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ABSTRACT

The first round of emissions testing of flexible fuel methanol vehicles from the U.S. federal fleet was completed in 1995. The vehicles tested include 71 flexible fuel M85 1993 Dodge Spirits, 16 flexible fuel 1994 M85 Ford Econoline Vans, and a similar number of standard gasoline Dodge Spirits and E150 Ford Econoline Vans. Results presented include a comparison of regulated exhaust and evaporative emissions and a discussion of the levels of air toxins, and the ozone-forming potential (OFP) of the measured emissions.

Three private emissions laboratories tested vehicles taken from the general population of federal fleet vehicles in the Washington D.C., New York City, Detroit, Chicago, and Denver metropolitan regions. Testing followed the standard U.S. Environmental Protection Agency's Federal Test Procedures (FTPs) and detailed fuel changeover procedures as developed in the Auto/Oil Air Quality Improvement Research Program. Flexible fuel vehicles (FFVs) were tested using fuels consisting of 85% methanol to 15% gasoline (M85), 50% methanol to 50% gasoline (M50), and California Phase 2 reformulated gasoline (RFG).

All vehicle/fuel combinations showed emissions well below the certification standards (including the more stringent Tier I standards). At these levels, the magnitude of the fuel-to-fuel differences in emissions from FFVs was relatively low. In general, there appeared to be a small drop in non-methane hydrocarbons (NMHCs), and carbon monoxide (CO), and an increase in oxides of nitrogen (NO_x) for M85 compared to the same vehicles tested on RFG. The OFP (expressed in grams of ozone per mile) from the M85 tests were 40% to 50% lower than the RFG tests performed on the Dodge Spirits and Ford Econoline vans. The M85 tests also showed lower levels of benzene and 1,3-butadiene but increased formaldehyde.

INTRODUCTION

The National Renewable Energy Laboratory (NREL) is managing a series of light-duty vehicle chassis dynamometer emissions tests on alternative fuel vehicles (AFVs) for the U.S. Department of Energy (DOE). This program is part of a larger demonstration of AFVs that was mandated by the Alternative Motor Fuels Act of 1988 (AMFA). As part of the AMFA program, vehicle performance, operational costs, maintenance, and fuel economy data are also being collected by NREL's Alternative Fuels Utilization Program and disseminated through the Alternative Fuels Data Center (AFDC).

During the first phase of the AMFA emissions test program (AMFA I) 18 vehicles were tested by three laboratories [1]. The vehicles tested included M85 (85% methanol, 15% gasoline) variable fuel Chevrolet Luminas, standard gasoline Chevrolet Luminas, M85 flexible fuel Ford Tauruses, and standard gasoline Ford Tauruses. All vehicles tested under AMFA I were 1991 model year vehicles. The second phase (AMFA II) used the lessons learned in AMFA I to identify areas of concentration and design a program to achieve increased certainty in the results. In AMFA II the baseline test fuel was changed from Amoco Indolene® to California Phase 2 reformulated gasoline (RFG) the number of vehicles was increased to nearly 300, including M85 Dodge Spirits, E85 (85% ethanol, 15% gasoline) Chevrolet Luminas, and compressed natural gas (CNG) Dodge passenger vans. Also, detailed speciation of hydrocarbon (HC) emissions was added to the program.

The AMFA II testing laboratories were selected on the basis of a competitive bidding process in which experience with performing the Federal Test Procedures (FTPs), in particular, FTP testing of alcohol and natural gas vehicles was stressed. The AMFA II testing is being done by three private emissions test facilities, including Environmental Research and Development (ERD) in the Washington D.C. area, Automotive Testing Laboratories (ATL) in East Liberty, Ohio, and ManTech Environmental Technology, Inc. (ManTech), in Denver, Colorado. Before testing began, a coordination meeting was held between all participating laboratories and NREL to ensure consistency in the test procedures. Laboratory site visits were conducted by NREL and U.S. Environmental Protection Agency (EPA) employees to ensure the consistency of the test procedure, calibration procedures, etc.

This paper covers the first round of AMFA II testing of the methanol flexible fuel vehicle (FFV) Dodge Spirits and Ford Econoline vans. These tests were performed between March of 1994 and June of 1995.

TEST VEHICLES

The vehicles covered in this paper are methanol FFVs and standard gasoline 1993 Dodge Spirits, and 1993 Ford

Table 1 - Test Vehicle General Specifications

General

Make	Dodge	Ford
Model	Spirit	Econoline E150
Type	4 door sedan	Full size passenger van
Model Year	1993	1992-1993
ENGINE		
Displacement	2.5 liter	4.9 liter
Horsepower	100	145
Configuration	In-line 4-cylinder	In-line 6-cylinder
Compression Ratio	8.9 : 1	8.8 : 1
Fuel Injection	Multi-point	Multi-point

Unique FFV Components

Dodge Spirits	Ford Econoline Vans
Methanol compatible fuel system materials	Methanol compatible fuel system materials
Larger Fuel Tank	Additional evaporative canister
% methanol fuel sensor	% methanol fuel sensor
High capacity fuel flow injectors	High capacity fuel flow injectors
Engine computer program	Engine computer program
	Spark plugs with wider electrodes

Econoline E150 vans. The FFV models are designed to run on blends of methanol and gasoline from 85% methanol/15% gasoline to 0% methanol/100% gasoline. It should be noted that the FFV Dodge Spirits are EPA certified production vehicles while the FFV Ford Econoline vans are uncertified prototype demonstration vehicles. General specifications for these vehicles are shown in Table 1. The Dodge Spirits are light-duty passenger cars with 2.5-liter, 100-horsepower, 4-cylinder engines, multipoint fuel injection, and a compression ratio of 8.9 : 1. The E150 Ford Econoline vans are full-size passenger vans classified by EPA for emissions certification purposes as a heavy light-duty truck. They have 4.9-liter, 145-horsepower, in-line 6-cylinder engines, with multipoint fuel injection and a 8.8 : 1 compression ratio. Both vehicle designs include methanol compatible materials in the fuel system, a special fuel sensor to measure the percentage of methanol in the fuel, higher capacity fuel flow injectors, and the appropriate changes to the engine computer programming.

All test vehicles participating in this program are part of the federal vehicle pool leased to various government fleets through the General Services Administration (GSA). A large number of vehicles were selected for testing because the vehicle usage and care vary from site to site. Vehicle service may vary widely from short delivery routes to highway driving, and the level at which the original equipment manufacturer's preventive maintenance schedule is followed depends, to a certain extent, on the diligence of the fleet operator. Over the life of the program, variability in the emissions level is therefore expected to be fairly high from vehicle to vehicle. However, most (approximately 90%) vehicles were tested at odometer readings of less than 20,000 miles and did not require maintenance, such as air filters or tune-ups, that could affect emissions levels. Fleet personnel are notified of upcoming tests and are asked to ensure that the vehicle scheduled for testing has received normal preventive maintenance and that it is in normal operating condition. Nevertheless, each vehicle goes through a general inspection when it arrives in the test laboratory. Based on the general inspection, the vehicle may undergo a minor repair (replace fuel cap, tighten fitting, etc.) at the laboratory, be sent to an authorized dealership for maintenance, be returned to the fleet with notification of a problem, or be prepared for testing.

Table 2 shows the number of vehicles tested and tests performed at each of the three participating laboratories. The number of tests is greater than the number of vehicles because duplicate tests were performed on several vehicles. During the first round of testing, a complete set (all fuels) of repeat tests was performed on at least two of each vehicle model at each laboratory. Additionally, repeat tests were performed based on

agreement between the results of the EPA Emissions Certification FTP to a subsequent inspection and maintenance (IM240) emissions test. The repeat tests based on this comparison were deleted due to the high number of repeats required and a study that showed relatively poor correlation between the FTP and the IM240 test results applied in this manner.[2]

During the first round of testing, the vehicles were tested at odometer readings between 4,000 and 40,000 miles. The distribution of odometer readings at the time of testing is shown in Figure 1. Approximately 90% of the FFV Dodge Spirits were tested at odometer readings less than 20,000 miles, and 91% of the FFV Ford Econoline vans were first tested at odometer readings less than 30,000 miles. Although there is a considerable difference in the distribution of test mileages between the FFVs and standard gasoline Dodge Spirits, the primary comparisons made are between the fuels tested in the FFVs. The results from the standard gasoline control vehicles are used as a reference base.

TEST FUELS – Physical properties of the three test fuels used in this program are summarized in Table 3. The methanol and gasoline test fuels were blended and supplied to each laboratory by Phillips Petroleum. California Phase 2 (RFG) was specified to represent a modern gasoline baseline to compare them with the methanol blends. The Auto/Oil Air Quality Improvement Research Program (AQIRP) has compared the emissions from an industry average gasoline to RFG for similar vehicles.[3] The two methanol blends used in the testing are 85% methanol with 15% RFG (M85), and 50% methanol with 50% RFG (M50).

TEST PROCEDURES – The complete procedure for testing a vehicle is outlined in Figure 2. The test sequence was preceded by fleet notification, verification of scheduled maintenance and acceptable vehicle performance, and an incoming vehicle inspection at the laboratory. Once a vehicle was approved for testing, an extensive procedure designed to minimize the fuel changeover effects was performed. Each FFV was tested on RFG, M85, and M50 in random order. The standard gasoline vehicles were tested on RFG. The fuel changeover procedure was performed before every test, including the first test in the sequence. This process follows the AQIRP vehicle testing procedures.[4] The main elements of the fuel changeover procedure are a 60-min purge of the vehicle's evaporative canister, several fuel tank drain and fill sequences, a chassis dynamometer driving cycle using the test fuel, and several engine start-up and idle sequences.

When the preparation procedure was complete, each vehicle was tested following the EPA's FTP for light-duty vehicle chassis dynamometer testing.[5] This included a complete fuel drain and 40% refill with the test fuel at room temperature, followed by a dynamometer preconditioning driving cycle and a temperature-controlled soak for 12 to 36 h. After the soak time, the fuel was again drained and filled to 40% capacity with test fuel at 45°–60°F. The vehicle was then pushed into the sealed housing evaporative enclosure where the EPA diurnal heat build sealed housing evaporative determination (SHED) was performed. To determine the vehicle's evaporative HC loss, initial and final HC and methanol measurements were taken from the evaporative enclosure as the temperature of the vehicle's fuel tank was raised from 60°F to 84°F during a period of 60 min. Within 1 h of the diurnal SHED test, the vehicle was pushed onto the dynamometer, started, and driven through the three phases of the exhaust FTP using the urban dynamometer driving schedule (UDDS).

Three samples of dilute exhaust gas from the constant volume sampling system were collected during the exhaust FTP corresponding to the cold transient (bag 1) phase, the hot stabilized (bag 2) phase and the hot transient (bag 3) phase. These "bag" samples were analyzed for HCs using a flame ionization detector (FID, heated to 235 ±15°F for alcohol fuel tests), methane (CH_4) using an FID combined with a gas chromatograph, NO_x using a chemiluminescence analyzer, and CO and CO_2 using nondispersive infrared analyzers as prescribed by standard FTP certification. Alcohol samples are collected by drawing dilute air and exhaust gas samples through primary and secondary impingers chilled in an ice-bath to 0°–5° C. Analysis of the alcohol samples was performed by gas chromatography.

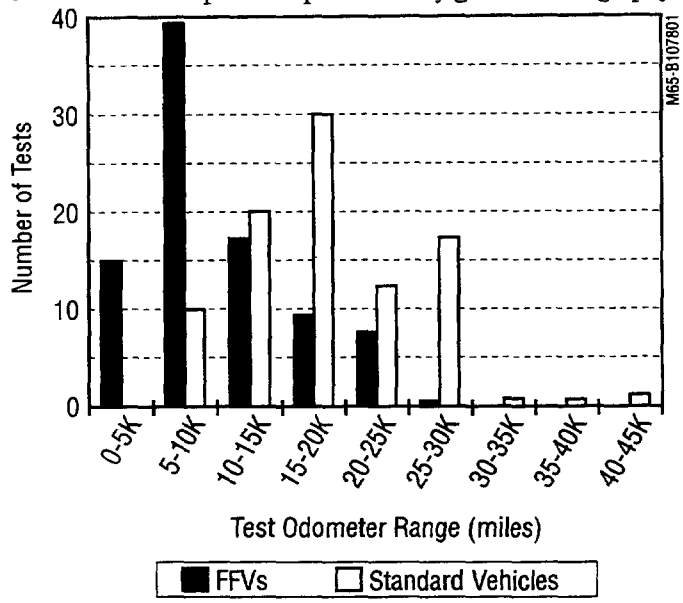

Figure 1a. Test Odometer Distribution for Dodge Spirits

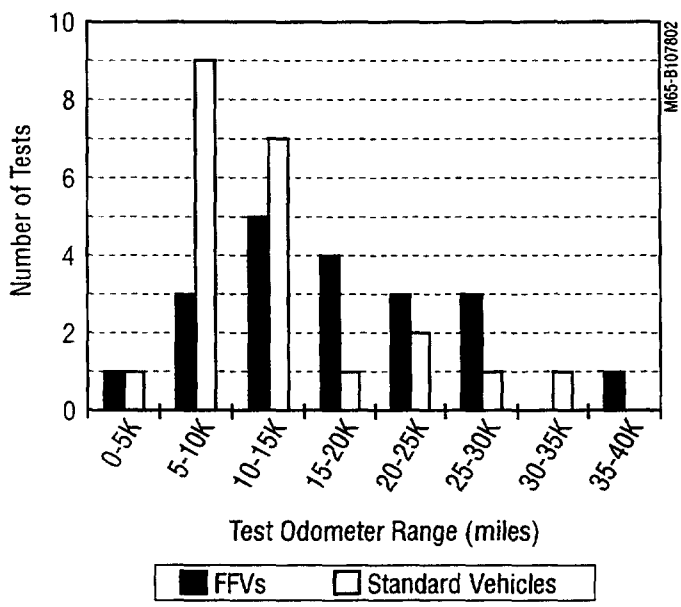

Figure 1b. Test Odometer Distribution for Ford Econoline Vans

Table 2 - Number of FTP Emissions Tests

Vehicle Type	Lab ID No.	M85 Tests	M85 Vehicles	M50 Tests	M50 Vehicles	RFG Tests	RFG Vehicles
FFV Dodge Spirit	1	33	25	37	25	29	24
	2	27	24	24	24	22	22
	3	29	22	29	22	34	22
	SUM	**89**	**71**	**90**	**71**	**85**	**68**
Standard Spirit	1					37	25
	2					24	22
	3					33	22
	SUM					**94**	**69**
FFV Econoline Van	2	11	9	10	8	11	9
	3	9	7	9	7	9	7
	SUM	**20**	**16**	**19**	**15**	**20**	**16**
Standard Econoline Van	2					12	10
	3					10	8
	SUM					**22**	**18**

Table 3 - Test Fuel Analysis

	M85	M50	RFG
Fuel Blend	85% Methanol 15% RFG	50% Methanol 50% RFG	100% RFG
Specific Gravity	0.787	0.767	0.741
Carbon (wt %)	44.1	60.2	84.4
Hydrogen (wt %)	12.7	13.1	13.6
Oxygen (wt %)	43.1	26.8	2.0
Net Heat of Combustion (Btu/gal)	64,600	84,100	111,960
Reid Vapor Pressure (psi)	7.5	9.5	6.9

Aldehyde samples are collected on dinitrophenylhydrazine (DNPH) coated silica cartridges or in DNPH/Acetonitrile solutions in impingers, and analyzed using high performance liquid chromatography.

The hot soak evaporative emissions test defined by the FTP was performed immediately after the hot transient phase (bag 3) of the exhaust emissions test. Evaporative losses were determined from HC and methanol analysis of the enclosure atmosphere at the start and end of the 60-min test period.

Full speciation of the exhaust and evaporative HCs from a sample of the vehicles (as indicated in Table 4) was performed using gas chromatography. The HC speciation quantified the

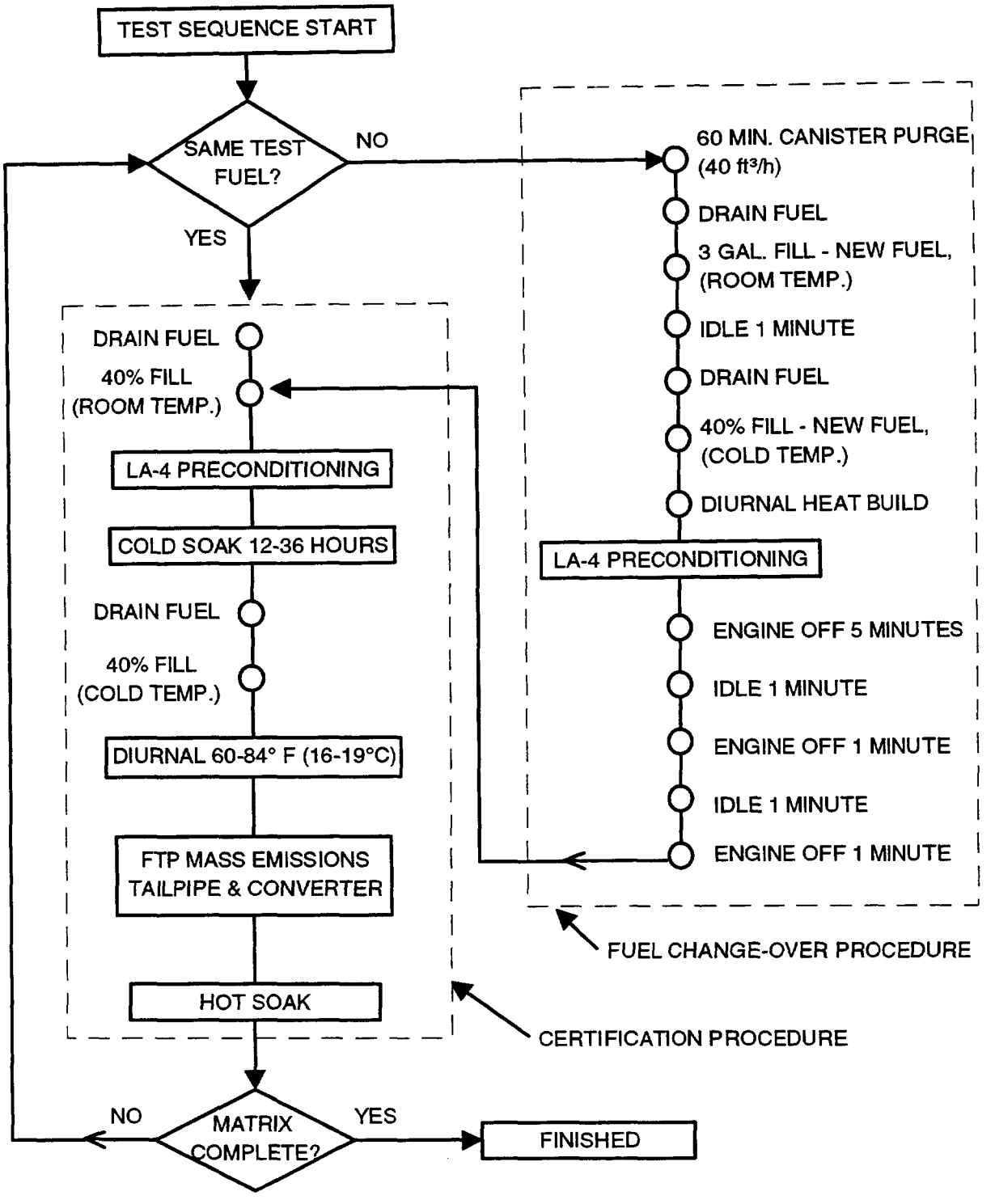

Figure 2. Vehicle Testing Procedure

Table 4 - Number of Hydrocarbon Speciation Tests

Lab Number	Vehicle Model	Vehicle Type	Test Fuel	No. of Vehicles	No. of Tests
1	Spirit	FFV	M85	4	5
		FFV	M50	4	6
		FFV	RFG	4	4
1	Spirit	Standard	RFG	4	4
3	Spirit	FFV	M85	2	2
		FFV	M50	2	2
		FFV	RFG	2	2
3	Spirit	Standard	RFG	2	2
3	Econoline	FFV	M85	2	2
			M50	2	2
			RFG	2	2
	Econoline	Standard	RFG	2	2

concentration of more than 100 HC constituents in the emissions samples. A complete list of the candidate HC species is shown in Appendix A.

RESULTS AND DISCUSSION

All data (bag-specific exhaust, evaporative, and HC speciation) from the testing of GSA alternative fuel and standard gasoline Dodge Spirits and Ford Econoline vans, as well as emissions test data from other vehicles and fuels not covered in this paper, can be found in the AFDC, accessible via the World Wide Web at the following internet address: "http://www.afdc.nrel.gov/web_view/emishome.html". A summary of the FTP weighted average exhaust emissions and evaporative emissions is presented in Appendices B and C of this report.

The following discussion presents a comparison of regulated exhaust emissions including HCs, CO, NO_x, evaporative HC emissions, nonregulated emissions such as exhaust toxic emissions, and the ozone-forming potential (OFP) of the exhaust emissions. Tables 5 and 6 summarize the EPA certification standards for the Dodge Spirit (light-duty vehicle) and the Ford Econoline van (heavy light-duty truck) respectively.[6] Vehicle models from 1993 were certified under the Tier 0 standards (shown in bold). The Tier 1 standards are phased in beginning with the 1994 model year. The two emissions standards are included here to indicate how the EPA certification standards are changing and how the test results in this program compare to the tougher standards. Methanol fuel vehicle exhaust and evaporative HCs are regulated by EPA as organic material hydrocarbon equivalent (OMHCE). The Code of Federal Regulations' definition of OMHCE includes HCs as well as the equivalent HC portion of aldehydes and methanol.[7]

$$OMHCE = HC + \frac{13.8756}{32.042} CH_3OH + \frac{13.8756}{30.0262} HCHO$$

The Tier 1 EPA HC certification standards for methanol vehicles are written in terms of the non-methane portion or organic material non-methane hydrocarbon equivalent (OMNMHCE). The certification standard for evaporative emissions is 2.0 grams total evaporative HC emissions per test. The total evaporative HC emissions are defined as the sum of the HC loss from the diurnal and hot soak SHED tests. For methanol tests this is calculated as follows:

$$HC_{evap} = (HC_{diurnal} + \frac{14.3594}{32.042} CH3OH_{diurnal}) + (HC_{hotsoak} + \frac{14.2284}{32.042} CH3OH_{hotsoak})$$

Regulated Emissions from Dodge Spirits

Table 7 shows the average and coefficient of variance (CV) for regulated exhaust and evaporative emissions from the FTP emissions testing of FFV and standard gasoline Dodge Spirits. The averages and CVs were calculated after removing data points outside a band of +/- 3 standard deviations. Figure 3 shows graphical representations of the values presented in Table 7. The tables in Appendix B show the complete set of data points. The

Table 5 - Intermediate useful life (5 years, 50,000 miles) Standards for Light-Duty Vehicles (g/mi)

Fuel	Standard	THC	NMHC	OMHCE	OMNMHCE	CO	NO_x
Gasoline	**Tier 0**	**0.41**				**3.4**	**1.0**
Gasoline	Tier 1	0.41	0.25			3.4	0.4
Methanol	**Tier 0**			**0.41**		**3.4**	**1.0**
Methanol	Tier 1			0.41	0.25	3.4	0.4

Table 6 - Intermediate useful life (5 years, 50,000 miles) Standards for Heavy Light-Duty Trucks (g/mi)

Fuel	Standard	THC	NMHC	OMHCE	OMNMHCE	CO	NO_x
Gasoline	Tier 0	**0.8**				**10**	**1.7**
Gasoline	Tier 1	0.8	0.39			5.0	1.1
Methanol	Tier 0			**0.8**		**10**	**1.7**
Methanol	Tier 1			0.8	0.39	5.0	1.1

statistics shown in the appendix tables were calculated before the outliers were removed.

Figure 3 clearly shows that the regulated emissions results from Dodge Spirit FFVs were quite low compared to the certification standards. The average emissions were substantially lower than the Tier 1 emissions certification standards for all three fuels. The low emissions levels make percentage comparisons somewhat misleading. For instance, Lab 1 showed a 34% increase in NO_x emissions from M85 compared to RFG. The M85 average is only 0.049 grams per mile higher than the RFG average of 0.144 grams per mile. The RFG value is 86% below the Tier 0 certification standard, and the M85 value is 81% below the Tier 0 standard.

The average NMHC and OMNMHCE (see Figure 3a) emissions from all Dodge Spirits tested were approximately 70% lower than the Tier 0 emissions standard and approximately 50% of the more stringent Tier 1 standards. At Labs 1 and 3, the FFVs tested on alcohol fuels tended to have 20% to 30% lower NMHC emissions compared the FFVs tested on RFG. Lab 2 showed very little difference in FFV emissions results between the vehicles. NO_x emissions from the FFVs (see Figure 3b) were also very low (approximately 75% lower than the Tier 0 standard and 50% lower than the Tier 1 standard). Lab 2 showed very little difference in NO_x emissions from fuel to fuel for the FFVs. The M85 NO_x emissions at Labs 1 and 3 were approximately 35% higher than the RFG tests. Overall, the average CO emissions (see Figure 3c) results were approximately 50% lower than emissions standard (for CO Tier 0 = Tier 1). Labs 1 and 3 showed very small reductions (between 3% and 9%) for FFV alcohol fuel tests compared to FFV RFG tests. Lab 2 showed a small (13%) increase for M85 over RFG.

In general, Labs 1 and 3 agreed well with exhaust emissions from FFVs, showing a decrease in NMHCs, an increase in NO_x, and very little change in CO. Lab 2 showed very little difference (less than 10%) between fuels for NMHC and NO_x, and a small (13%) increase in CO for M85 over RFG.

The three laboratories showed similar trends when comparing the FFV tested on RFG to the standard gasoline vehicles tested on RFG. In general the NMHC and CO emissions were lower, and NO_x emissions were higher from the standard gasoline vehicles compared to the FFVs tested on RFG. For the standard gasoline vehicles tested on RFG, the NMHC emissions were 30% to 50% lower, the CO emissions 1% to 19% lower, and the NO_x emissions 70% to 144% higher than the FFVs tested on RFG.

The evaporative HC emissions (see Figure 3d) were also considerably lower than the certification standard. The results for M85 and RFG from the three laboratories agreed quite well and show very little difference between the two fuels. Lab 1 showed substantially higher evaporative emissions for M50. This could be due, in part, to the higher Reid vapor pressure (RVP) of the M50 fuel (RVP_{M85} = 7.5 psi, RVP_{M50} = 9.5 psi, RVP_{RFG} = 6.4 psi), but Labs 2 and 3 did not show this effect.

The variability from vehicle to vehicle (expressed as the CV in Table 7) agreed quite well between laboratories. Table 7 shows that NO_x results had the highest CV (ranging from 0.35 to 0.63 for the FFVs) of any of the regulated emissions for all fuels and at all laboratories. The NMHC results had the lowest CV (ranging from 0.12 to 0.28). For nearly all the emissions components (HC, NO_x, CO, and evaporative HCs) the results from the standard gasoline vehicles were less variable than from the FFVs.

Table 7 - Regulated Emissions from Dodge Spirits

DODGE SPIRIT

Flexible Fueled Vehicles

			Regulated Exhaust Emissions (g/mi)						Evap (gm)	
	TEST	VEHICLE	(OM)NMHCE		NOx		CO		THC	
LAB	FUEL	COUNT	AVG	CV	AVG	CV	AVG	CV	AVG	CV
LAB 1	RFG	24	0.130	0.193	0.144	0.541	1.404	0.235	0.619	0.476
LAB 2	RFG	22	0.113	0.121	0.133	0.404	1.719	0.242	0.288	0.317
LAB 3	RFG	22	0.165	0.277	0.165	0.350	1.845	0.220	0.457	0.417
LAB 1	M50	25	0.098	0.144	0.192	0.574	1.392	0.286	0.986	0.519
LAB 2	M50	24	0.102	0.184	0.147	0.446	1.666	0.259	0.338	0.345
LAB 3	M50	22	0.108	0.169	0.248	0.533	1.762	0.172	0.410	0.408
LAB 1	M85	26	0.107	0.171	0.193	0.626	1.359	0.221	0.597	0.300
LAB 2	M85	24	0.120	0.159	0.143	0.482	1.950	0.193	0.298	0.381
LAB 3	M85	22	0.113	0.160	0.226	0.503	1.678	0.239	0.377	0.464

Standard Gasoline Vehicles

			Regulated Exhaust Emissions (g/mi)						Evap (gm)	
	TEST		(OM)NMHC		NOx		CO		THC	
LAB	FUEL	COUNT	AVG	CV	AVG	CV	AVG	CV	AVG	CV
LAB 1	RFG	25	0.076	0.119	0.244	0.251	1.174	0.279	0.281	0.190
LAB 2	RFG	22	0.080	0.152	0.306	0.342	1.698	0.322	0.117	0.321
LAB 3	RFG	22	0.069	0.097	0.402	0.210	1.492	0.233	0.280	0.305

Table 8 - Regulated Emissions from Ford Econoline Vans

Ford Econoline E150 Van

Flexible Fuel Vehicles

			Regulated Emissions (g/mi)						Evap (gm)	
	TEST	VEHICLE	(OM)NMHCE		NOx		CO		THC	
LAB	FUEL	COUNT	AVG	CV	AVG	CV	AVG	CV	AVG	CV
LAB 2	RFG	9	0.150	0.285	0.779	0.229	2.201	0.306	0.523	0.860
LAB 3	RFG	7	0.155	0.141	0.727	0.426	2.146	0.190	0.323	0.557
LAB 2	M50	8	0.166	0.209	0.668	0.101	1.767	0.194	0.299	0.269
LAB 3	M50	7	0.135	0.179	0.863	0.388	1.905	0.202	0.216	0.405
LAB 2	M85	9	0.146	0.232	0.756	0.182	1.646	0.347	0.381	0.803
LAB 3	M85	7	0.122	0.187	0.953	0.437	1.298	0.170	0.226	0.626

Standard Gasoline Vehicles

		VEHICLE	Regulated Emissions (g/mi)						Evap (gm)	
	TEST	COUNT	(OM)NMHC		NOx		CO		THC	
LAB	FUEL	COUNT	AVG	CV	AVG	CV	AVG	CV	AVG	CV
LAB 2	RFG	10	0.268	0.089	0.809	0.122	3.236	0.074	0.265	0.197
LAB 3	RFG	8	0.275	0.190	0.954	0.117	3.270	0.160	0.548	0.751

Figure 3. Regulated Emissions from Dodge Spirits

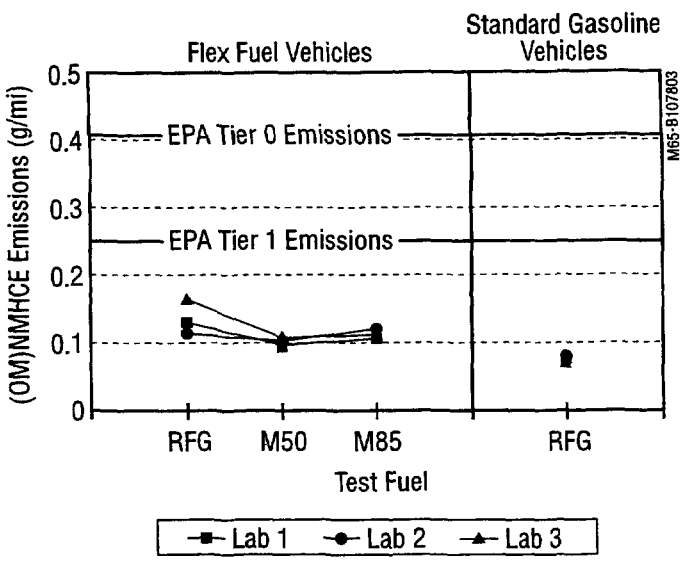

Figure 3a. (OM)NMHC emissions (g/mi)

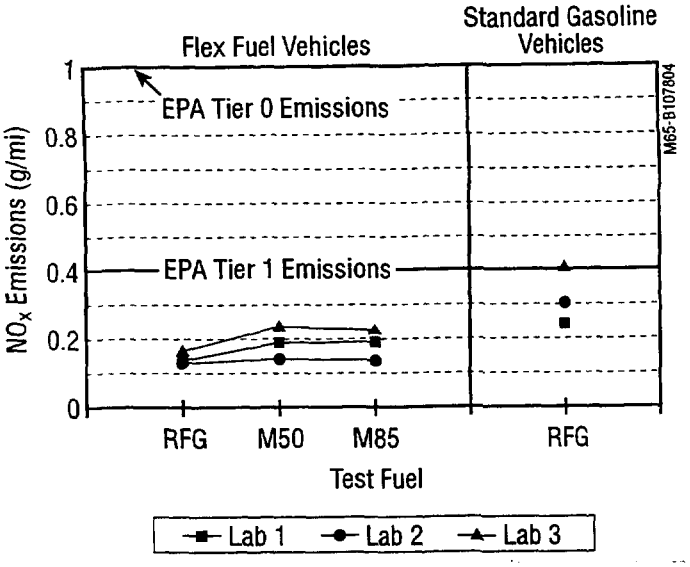

Figure 3b. NO_x emissions (g/mi)

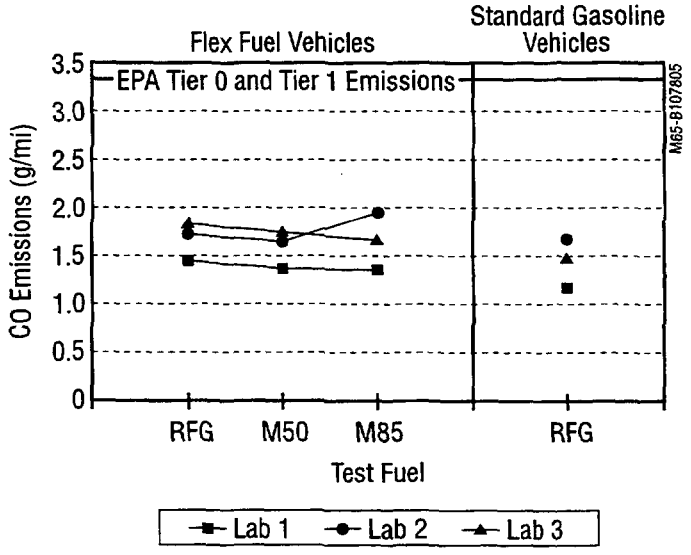

Figure 3c. CO emissions (g/mi)

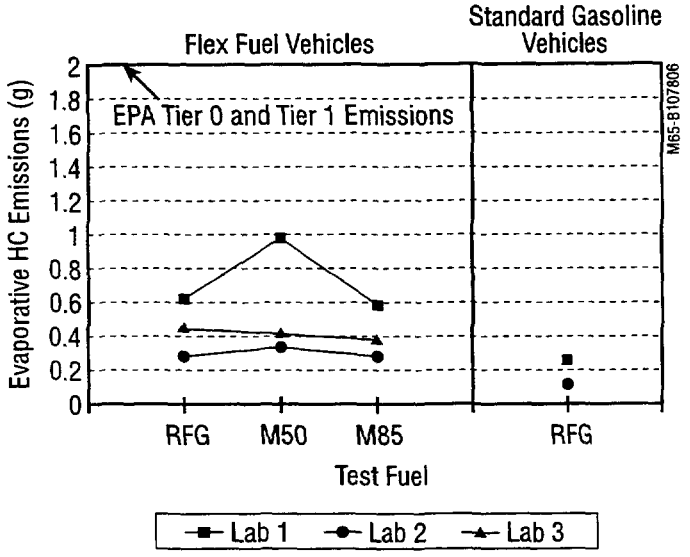

Figure 3d. Evaporative emissions (g)

EPA Regulated Emissions from Ford Econoline Vans

A smaller number of FFV Ford Econoline vans was available for testing at Labs 2 and 3 only. Table 8 shows the average and CV for regulated exhaust and evaporative emissions from the FTP emissions testing of FFV Ford Econoline vans for the three test fuels (RFG, M50, and M85), and the RFG test results for the standard gasoline Ford Econoline vans. The averages and CVs were calculated after removing data points outside a band of +/- 3 standard deviations. Figure 4 shows graphical representations of the values presented in Table 8. The tables in Appendix C show the complete set of data points. The statistics shown in the appendix tables were calculated before the outliers were removed.

As with the Dodge Spirits, the FFV regulated emissions results for Econoline vans were quite low compared to the EPA certification standards for heavy light-duty trucks (see Figure 4). NMHC and CO values were approximately 80% lower than the Tier 0 standard and 60% lower than the Tier 1 standards. The NO_x results were approximately 50% lower than the Tier 0 and 30% lower than the Tier 1 standards. When comparing emissions from M85 tests to the RFG test results, Lab 3 showed a 21% decrease in NMHC, a 40% decrease in CO, and a 31% increase in NO_x. Results from Lab 2 showed a 25% reduction in CO, and practically no difference in NMHC or NO_x.

The regulated emissions from the standard gasoline Econoline vans tested on RFG were generally higher than the RFG test results from the FFV Econoline vans. Lab 2 showed 79% higher NMHC, 4% higher NO_x, and 47% higher CO. Lab 3 showed 78% higher NMHC, 31% higher NO_x, and 52% higher CO.

The evaporative HC emissions (see Figure 3d) were approximately 85% below the 2.0 gram certification standard.

Figure 4. Regulated Emissions from Ford Econoline Vans

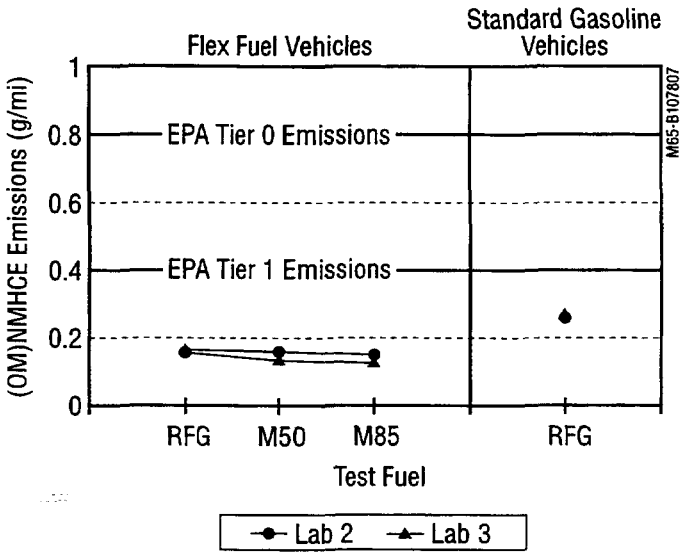

Figure 4a. (OM) NMHCE Emissions (g/mi)

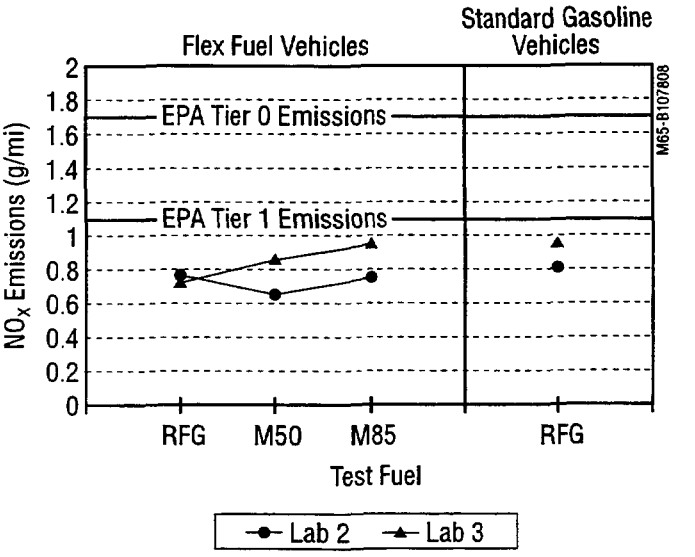

Figure 4b. NO_x Emissions (g/mi)

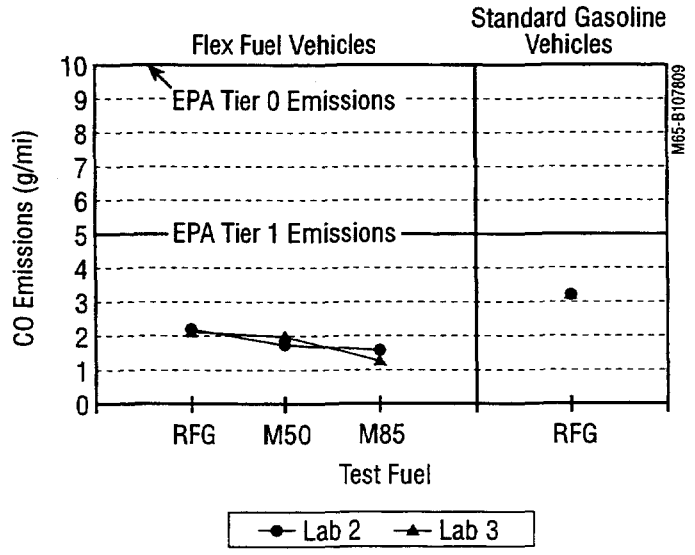

Figure 4c. CO Emissions (g/mi)

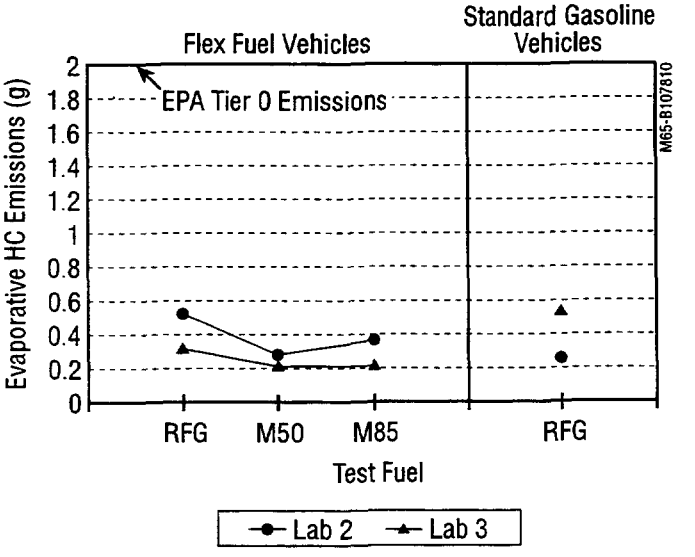

Figure 4d. Evaporative Emissions (g)

Both labs showed similar trends between fuels. The average M85 evaporative emissions were approximately 30% lower then the RFG from the FFVs. Typically, this was due to a few vehicles with higher evaporative emissions, but leaving these vehicles out did not change the trend between fuels.

Trends in the variability of the data were not as apparent as with the Dodge Spirit test data.

Speciation of Hydrocarbon Emissions

Speciation, or quantification of individual HC emissions components through gas chromatography, was performed on six Dodge Spirits tested at Labs 1 and 3, and two of the 10 Ford Econoline vans tested at Lab 3. A complete list of the HC compounds detected is shown in Appendix A. HC speciation can be used to compare the differences in the types of HC emitted by the various fuels. Figures 5 and 6 show the average distribution of exhaust HC species detected from FFV Dodge Spirits and Ford Econoline vans tested on M85, M50, and RFG. Two distributions are shown. The first distribution (Figure 5) groups the results by number of carbons from one carbon in CH_4 and CH_3OH through six carbons in HC compounds such as benzene, eight in iso-octane, up to 11 carbons. The second distribution (Figure 6) groups the results by HC "class" (alkane, aromatic, etc.). These distributions show how the profile of HC emissions vary from fuel to fuel. In general, the M85 test results show a much higher C1 component, but consistently lower amounts of C2 through C11 HCs. Similarly, the M85 results show greater amounts of oxygenates, but lower HCs classified as aromatics, alkanes, and alkenes.

Figure 5. Exhaust Hydrocarbon Distribution by Number of Carbon Atoms

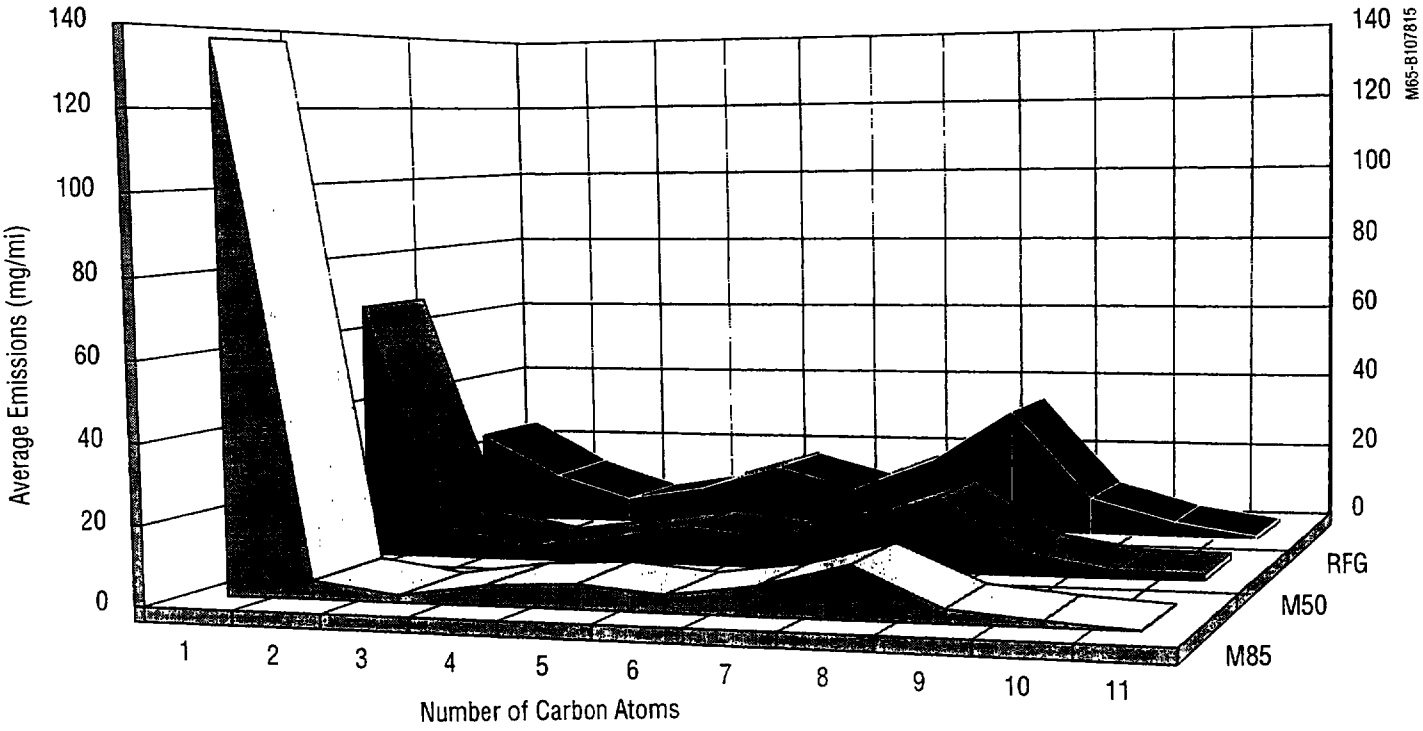

Figure 5a. Dodge Spirits

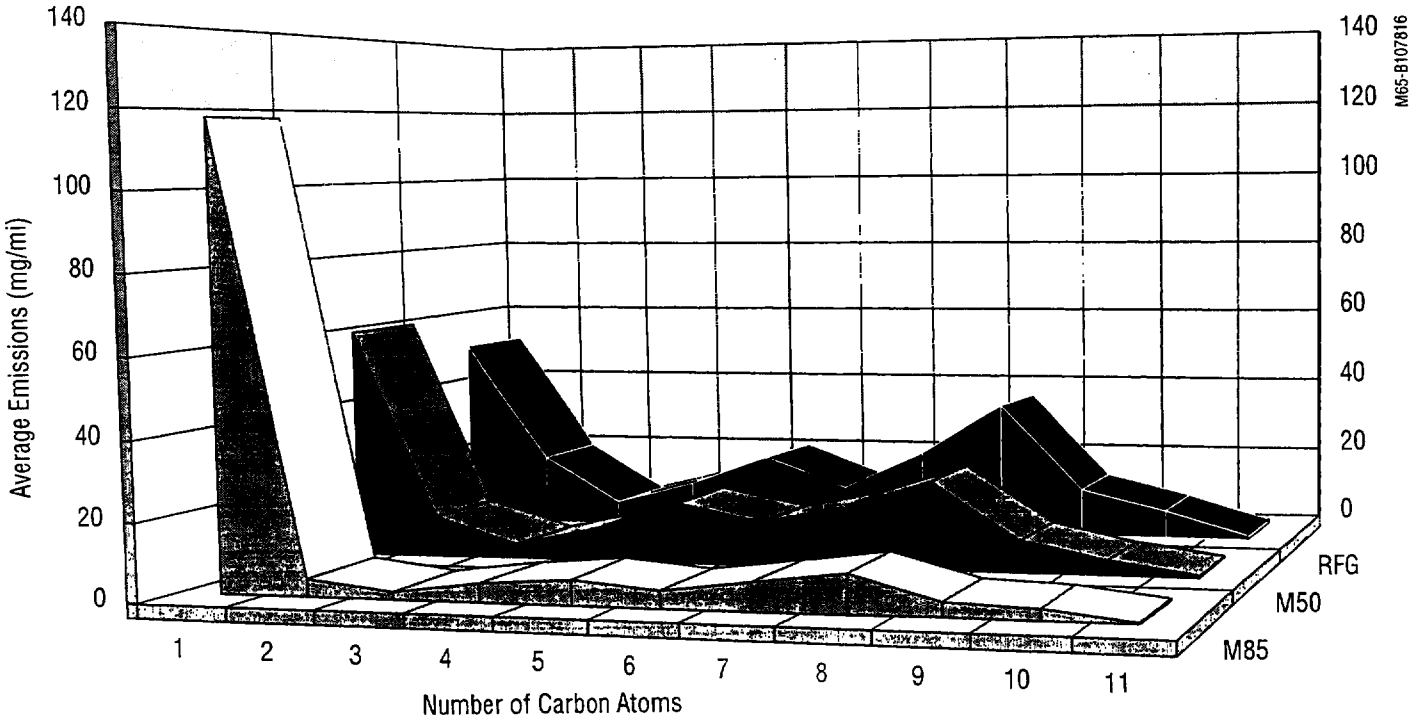

Figure 5b. Ford Econoline Vans

Figure 6. Exhaust Hydrocarbon Distribution by HC Class

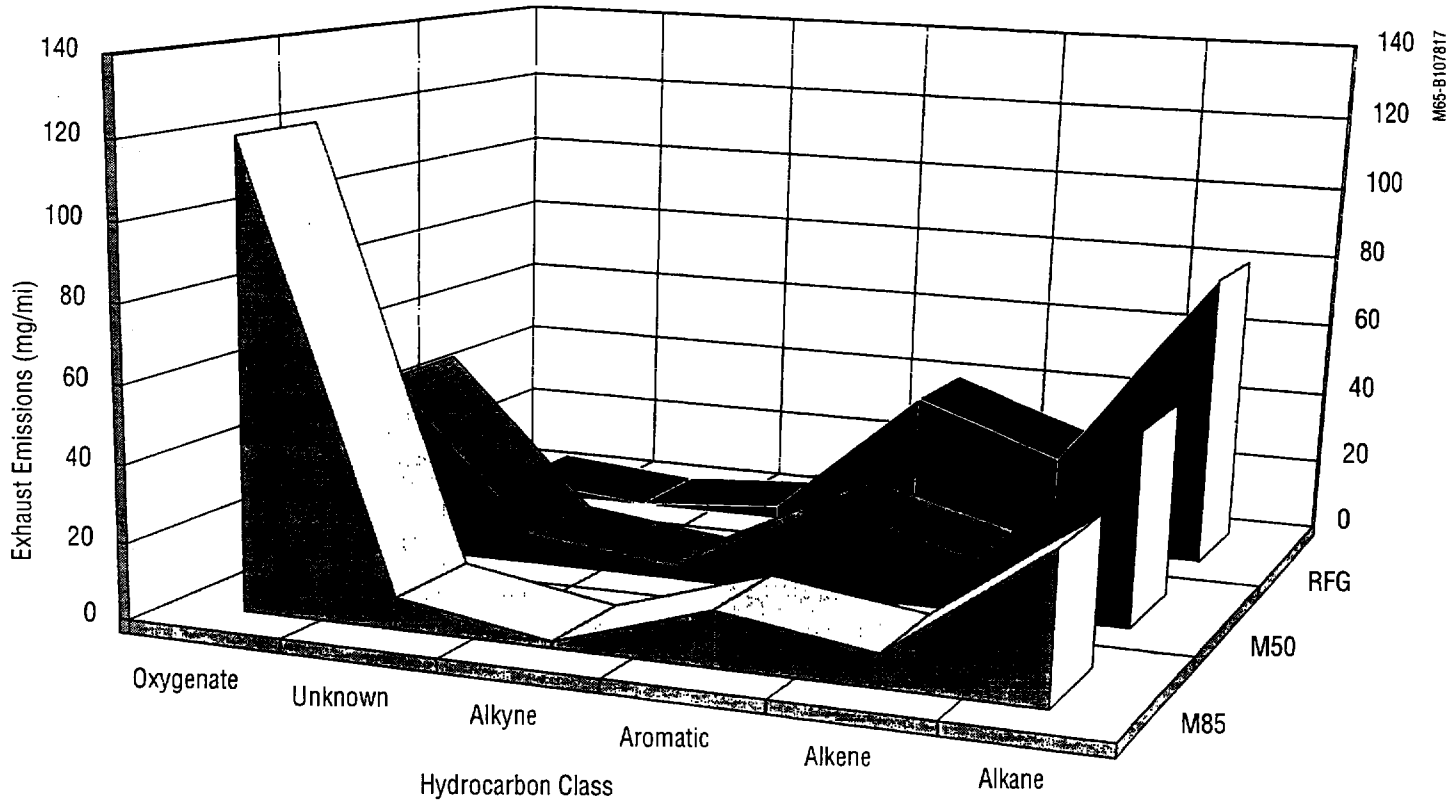

Figure 6a. Dodge Spirits

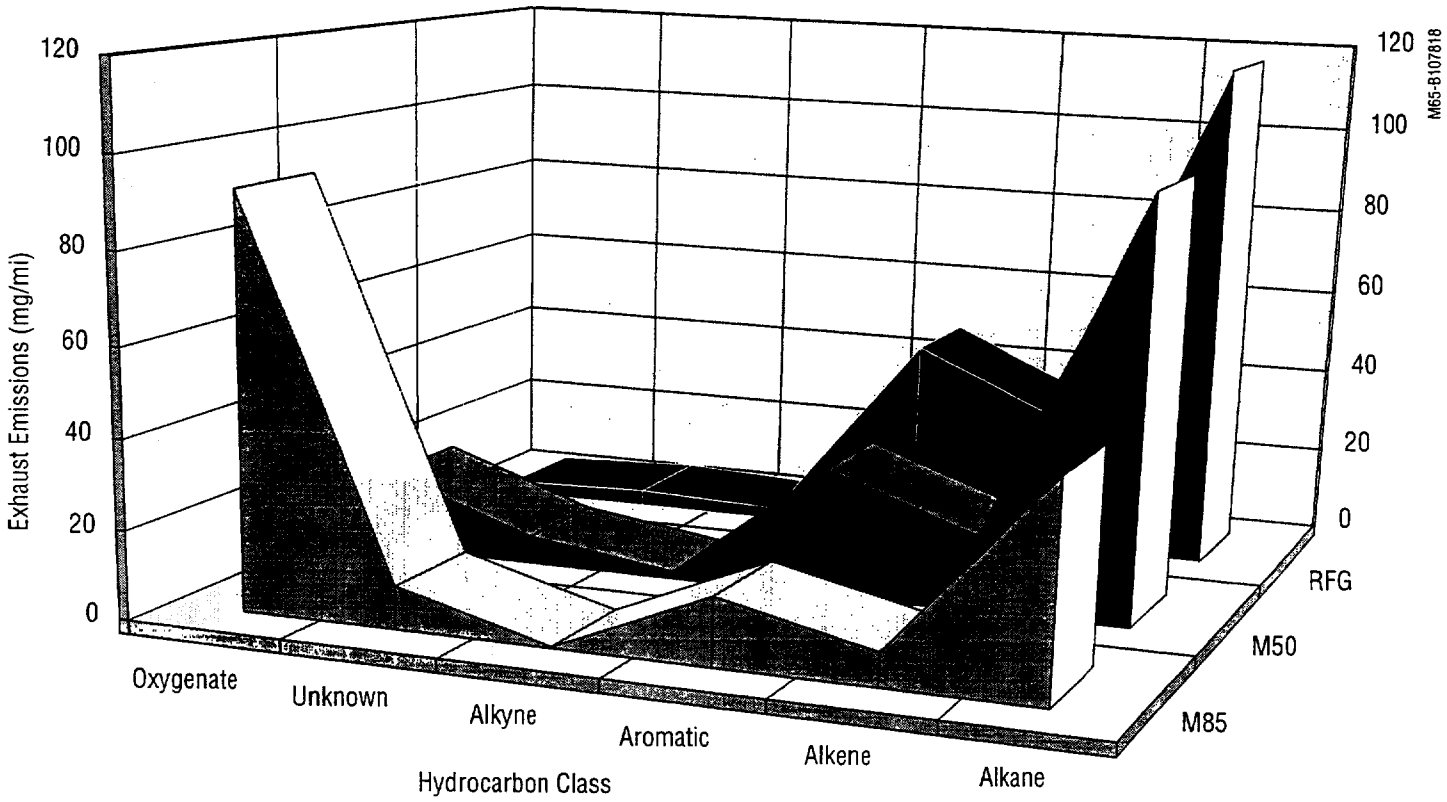

Figure 6b. Ford Econoline Vans

Table 9 - Average Air Toxic Exhaust Emissions - Dodge Spirits

Vehicle-Fuel	1,3-Butadiene		Benzene		Formaldehyde		Acetaldehyde	
	AVG (mg/mi)	CV	AVG (mg/mi)	CV	AVG (mg/mi)	CV	AVG (mg/mi)	CV
FFV-RFG	0.83	0.15	4.50	0.11	1.48	0.37	0.43	0.37
FFV-M50	0.37	0.13	2.96	0.15	6.23	0.32	0.41	0.31
FFV-M85	0.10	0.00	1.39	0.23	12.31	0.36	0.25	0.47
STD-RFG	0.30	0.19	2.15	0.29	1.09	0.31	0.30	0.43

Table 10 - Average Air Toxic Exhaust Emissions - Ford Econoline Vans

Vehicle-Fuel	1,3-Butadiene		Benzene		Formaldehyde		Acetaldehyde	
	AVG (mg/mi)	CV	AVG (mg/mi)	CV	AVG (mg/mi)	CV	AVG (mg/mi)	CV
FFV-RFG	0.45	0.11	4.40	0.14	1.48	0.04	0.41	0.24
FFV-M50	0.30	0.00	3.65	0.01	4.25	0.09	0.31	0.08
FFV-M85	0.10	0.00	1.70	0.06	8.13	0.01	0.15	0.38
STD-RFG	0.40	0.00	7.80	0.15	1.82	0.17	0.63	0.28

Two areas of particular interest with HC emissions from vehicles are air toxic emissions, and the contribution of HCs to ozone formation.

Air Toxic Emissions

Tables 9 and 10 and Figure 7 show the average emissions values of four HC components considered to have adverse affects on human health. The compounds covered include 1,3-butadiene, benzene, formaldehyde, and acetaldehyde. Formaldehyde is a primary decomposition product from methanol combustion and is expected to be higher from methanol than from other fuels.

In comparing the M85 to RFG air toxic emissions for the FFV Dodge Spirits, there was a 88% reduction in 1,3-butadiene, a 69% reduction in benzene, and a 42% reduction in acetaldehyde, but the formaldehyde emissions were nearly an order of magnitude higher for M85. Results for the two FFV Ford Econoline vans are similar. The 1,3-butadiene emissions were reduced by 78%, benzene by 61%, and acetaldehyde by 63%, but formaldehyde increased 449% for the M85 tests compared to the RFG tests.

Ozone-Forming Potential and Specific Reactivity

California emissions regulations assign a maximum incremental reactivity (MIR) value to individual compounds emitted in exhaust. The MIR value is the predicted impact of the compound on ozone formation in certain urban atmospheres and is expressed in units of milligrams of ozone per milligrams of compound. The MIR value is determined in a laboratory experiment in which a small increment of the compound is added to a simulated urban background mixture and the net increase in ozone is measured. Taking into account the MIR values for all measured exhaust compounds, an OFP for the fuel may be calculated in units of milligrams of ozone per mile. Specific reactivity (SR) for a given fuel may also be calculated by combining the respective mass of compound emissions per mile with the OFP, which results in units of milligrams of ozone per milligram of total organic emissions. In the California regulations, SR is based on non-methane organic gas (NMOG) emissions.

Tables 11 and 12 present the OFP and SR for the Dodge Spirits and Ford Econoline vans. Figure 8 presents the same information graphically. Both laboratories showed a significantly reduced OFP for FFVs tested on the alcohol fuels versus RFG. For the FFV Dodge Spirits, Lab 1 showed a 36% reduction and Lab 3 showed a 58% reduction in OFP when tested on M85 compared to RFG. For the FFV Ford Econoline vans, Lab 3 showed a 51% reduction in OFP when tested on M85 compared to RFG. There was strong agreement in SR values at the two laboratories. Lab 1 and 3 show reductions in OFP of 60% and 61% respectively for the FFV Dodge Spirit M85 tests compared to the RFG tests. Lab 3 showed a 51% reduction in SR for the FFV Ford Econoline tested on M85 compared to RFG.

SUMMARY OF RESULTS AND CONCLUSIONS

Table 13 summarizes the results from the first round of AMFA emissions testing of in-service methanol FFV Dodge

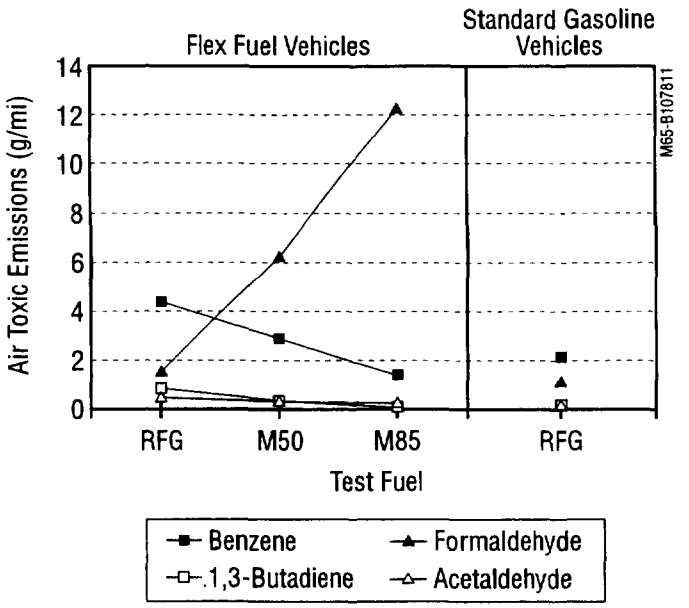

Figure 7a. Air Toxins for Dodge Spirits

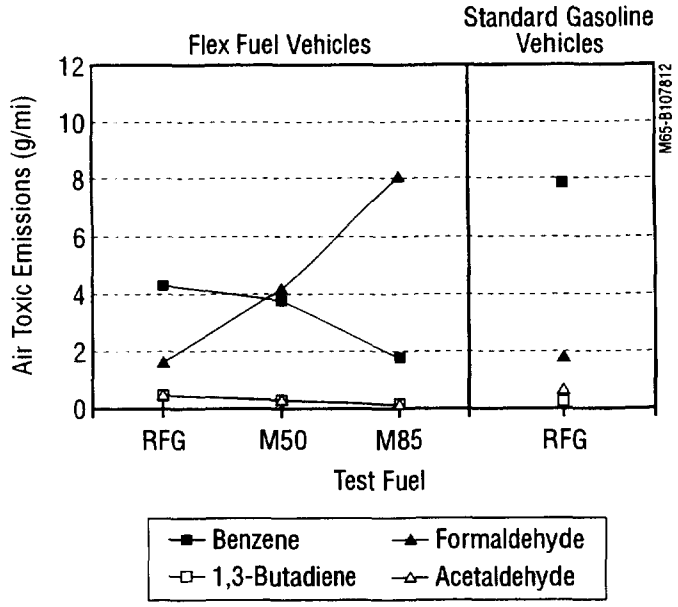

Figure 7b. Ford Econoline Vans

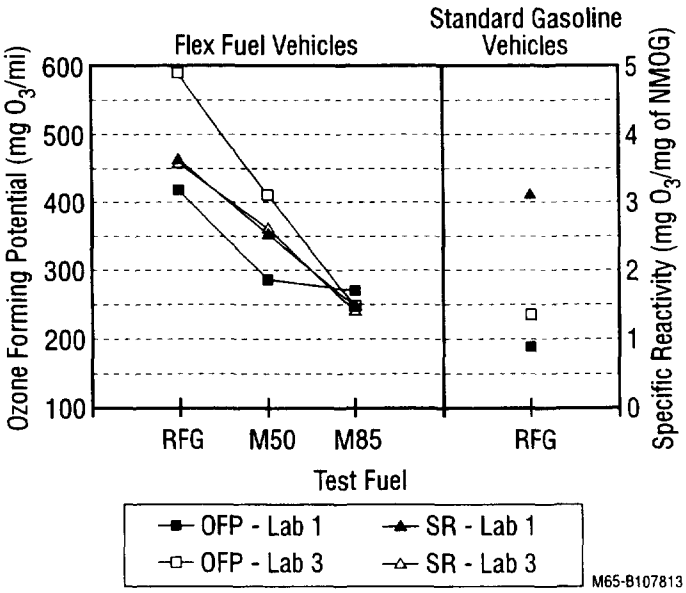

Figure 8a. Ozone-Forming Potential (OFP) for Dodge Spirits

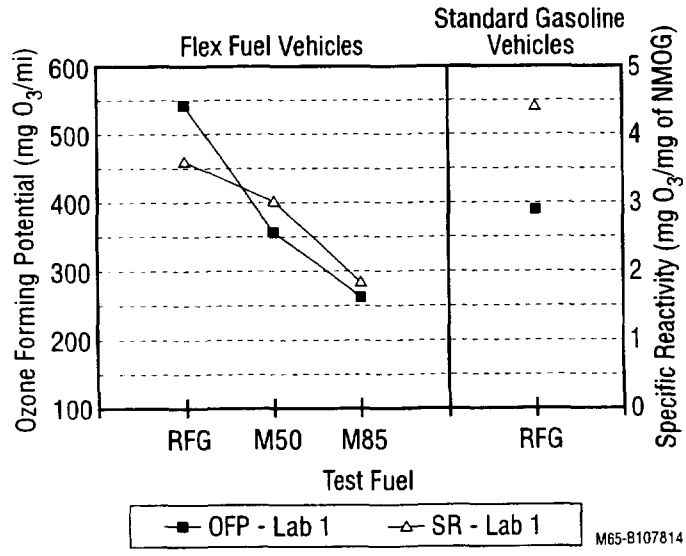

Figure 8b. Ford Econoline Vans

Spirits and Ford Econoline Vans. Overall, the emissions levels from all vehicles tested were substantially lower than the EPA Tier 0 certification levels, and most were even much lower than the more stringent Tier 1 certification levels. At these levels, the magnitude (measured in grams per mile for exhaust emissions, or grams of evaporative loss) of the differences in regulated emissions between fuels for the FFVs is relatively small. Labs 1 and 3 agreed quite well with the emissions trends from fuel to fuel.

Lab 2 to showed very little difference in average emissions levels between fuels. Labs 1 and 3 performed detailed speciation of the HC emissions, which agreed with the makeup or profile of the exhaust HC emissions. Although the reductions in NMHCs for M85 compared to RFG for FFVs were fairly modest (approximately 20% at Labs 2 and 3), differences in the profile of exhaust HCs amount to large reductions in toxic compounds (such as benzene and 1,3-butadiene), a very large increase in formaldehyde, and a large decrease in OFP exhaust. As additional testing at higher mileages are still being performed, the conclusions covered in this paper are preliminary. The following summary compares the FFV M85 test results to the FFV RFG test results:

Table 11 - Ozone-Forming Potential (OFP) and Specific Reactivity (SR) - Dodge Spirits

		Ozone Forming Potential (mg O_3/mile)		Specific Reactivity (mg O_3/mg NMOG)	
Test Fuel	Vehicle Type	OFP - Lab 1	OFP - Lab 3	SR - Lab 1	SR - Lab 3
RFG	FFV	419.8	587.3	3.7	3.6
M50	FFV	288	412.5	2.6	2.7
M85	FFV	270.9	249.1	1.5	1.4
RFG	STD	187.2	235.1	3.2	3.2

Table 12 - Ozone-Forming Potential (OFP) and Specific Reactivity (SR) -Ford Econoline Vans

Test Fuel	Vehicle Type	Ozone Forming Potential (mg O_3/mile)	Specific Reactivity (mg O_3/mg NMOG)
RFG	FFV	546.7	3.7
M50	FFV	359.5	3
M85	FFV	265.7	1.8
RFG	STD	388	4.4

1. Labs 1 and 3 showed an approximate reduction of 20% to 30% in NMHCs from M85 compared to the same vehicles tested on RFG. Lab 2 showed practically no change between the two fuels for both the Dodge Spirit and the Ford Econoline van.

2. Labs 1 and 3 showed an increase of approximately 35% in exhaust emissions of NO_x from M85 compared to the same vehicles tested on RFG. Lab 2 showed practically no change between the two fuels for both the Dodge Spirit and the Ford Econoline van.

3. Labs 1 and 3 showed a very small reduction in exhaust CO from the M85 FFV Dodge Spirit compared to the same vehicles tested on RFG. Lab 2 showed a 13% increase in exhaust CO from the M85 FFV Dodge Spirit compared to the same vehicles tested on RFG. Labs 2 and 3 showed 25% and 40% reductions, respectively, in exhaust CO from the M85 FFV Ford Econoline compared to the same vehicles tested on RFG.

4. Labs 1 and 3 (Lab 2 did not perform HC speciation) agreed quite well on exhaust toxic emissions. For M85 compared to RFG, the two labs showed approximate reductions of 60% to 70% for benzene, 80% to 90% for 1,3-butadiene, 42% to 48% for acetaldehyde, and a 500% to 750% increase in formaldehyde.

5. Labs 1 and 3 also agreed quite well on the differences in OFP and agreed strongly on SR of the exhaust emissions. Labs 1 and 3 showed a reduction in OFP of 36% to 58% for M85 compared to RFG. The SRs were 60% to 62% lower for the FFV Dodge Spirits tested on M85 and 51% lower for the Ford Econoline vans tested on M85.

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5. United States Office of the Federal Register. Revised as of July 1, 1995. *Code of Federal Regulations*. Title 40, Parts 86 to 99. Washington, DC: Office of the Federal Register.

6. 40 CFR 86-99. Revised as of July 1, 1995.

7. 40 CFR 86-99. Revised as of July 1, 1995.

Table 13 - Summary of Effects for M85 Compared to RFG Test on Flexible Fuel Vehicles

	Dodge Spirit			Ford Econoline	
	Lab 1	Lab 2	Lab 3	Lab 2	Lab 3
Regulated Emissions					
(OM)NMHCE	-17%	6%	-32%	-2%	-21%
NO_x	34%	8%	37%	-3%	31%
CO	-3%	13%	-9%	-25%	-40%
Evaporative HC	-4%	4%	-17%	-27%	-30%
Toxins					
Benzene	-68%		-73%		-61%
1,3-Butadiene	-88%		-89%		-78%
Formaldehyde	743%		587%		449%
Acetaldehyde	-43%		-48%		-42%
Specific Reactivity	-60%		-61%		-51%
Ozone-Forming Potential	-36%		-58%		-51%

Appendix A. Speciated Compounds

Compound Number	Compound Name	CAS Number	FORMULA
1	METHANE	74828	CH4
2	ETHYLENE	74851	C2H4
3	ETHANE	74840	C2H6
4	ACETYLENE	74862	C2H2
5	PROPANE	74986	C3H8
6	PROPYLENE	115071	C3H6
7	PROPADIENE	463490	C3H4
8	METHYLACETYLENE	74997	C3H4
9	ISO-BUTANE	75285	C4H10
11	1-BUTENE	106989	C4H8
12	ISO-BUTYLENE	115117	C4H8
13	1,3-BUTADIENE	106990	C4H6
14	N-BUTANE	106978	C4H10
15	2,2-DIMETHYLPROPANE	463821	C5H12
16	TRANS-2-BUTENE	624646	C4H8
17	1-BUTEN-3-YNE	689974	C4H4
18	1-BUTYNE	107006	C4H6
19	CIS-2-BUTENE	590181	C4H8
20	*** UNKNOWN ***		C4H8
21	1,3-BUTADIYNE	460128	C4H2
22	3-METHYL-1-BUTENE	563451	C5H10
23	ISO-PENTANE	78784	C5H12
24	1,4-PENTADIENE	591935	C5H8
25	2-BUTYNE	503173	C4H6
26	1-PENTENE	109671	C5H10
27	C5H8		C5H8
29	2-METHYL-1-BUTENE	563462	C5H10
30	N-PENTANE	109660	C5H12
31	ISOPRENE	78795	C5H8
32	TRANS-2-PENTENE	646048	C5H10
33	3,3-DIMETHYL-1-BUTENE	558372	C6H12
34	CIS-2-PENTENE	627203	C5H10
35	2-METHYL-2-BUTENE	513359	C5H10
36	TRANS-1,3-PENTADIENE	2004708	C5H8
37	CYCLOPENTADIENE	542927	C5H6
38	2,2-DIMETHYLBUTANE	75832	C6H14
39	CIS-1,3-PENTADIENE	1574410	C5H8
40	C5H8		C5H8
42	CYCLOPENTENE	142290	C5H8
44	4-METHYL-1-PENTENE	691372	C6H12
45	3-METHYL-1-PENTENE	760203	C6H12
45.501	*** UNKNOWN ***		
46	CYCLOPENTANE	287923	C5H10
48	2,3-DIMETHYLBUTANE	79298	C6H14
49	4-METHYL-CIS-2-PENTENE	691383	C6H12
51	2-METHYLPENTANE	107835	C6H14
52	4-METHYL-TRANS-2-PENTENE	674760	C6H12
53	C5H6		C5H6
54	C5H8		C5H8
55	*** UNKNOWN ***		C6H12
57	*** UNKNOWN ***		C6H12
58	3-METHYLPENTANE	96140	C6H14
59	2-METHYL-1-PENTENE	763291	C6H12
60	1-HEXENE	592416	C6H12
63	N-HEXANE	110543	C6H14
64	CIS-3-HEXENE	7642093	C6H12
64.501	TRANS-3-HEXENE	13269528	C6H12
65	TRANS-2-HEXENE	405045	C6H12
66	2-METHYL-2-PENTENE	625274	C6H12
66.501	3-METHYLCYCLOPENTENE	1120623	C6H10
67	CIS-3-METHYL-2-PENTENE	922623	C6H12
68	4-METHYLCYCLOPENTENE	1759815	C6H10
69	CIS-2-HEXENE	7688213	C6H12
70	C6H10		C6H10
72	TRANS-3-METHYL-2-PENTENE	616126	C6H12
72.501	2,2-DIMETHYLPENTANE	590352	C7H16
73	METHYLCYCLOPENTANE	96377	C6H12
76	2,4-DIMETHYLPENTANE	108087	C7H16

Compound Number	Compound Name	CAS Number	FORMULA
135	2,2,5-TRIMETHYLHEXANE	3522949	C9H20
136	1-OCTENE	111660	C8H16
136.501	TRANS-1-ETHYL-3-METHYLCYCLOPENTANE	2613652	C8H16
137	CIS-1-ETHYL-3-METHYLCYCLOPENTANE	2613663	C8H16
138	C8H16		C8H16
139	C8H16		C8H16
140	C8H16		C8H16
141	N-OCTANE	111659	C8H18
142	C8H16		C8H16
142.501	TRANS-1,2-DIMETHYLCYCLOHEXANE	6876239	C8H16
143	1,1,2-TRIMETHYLCYCLOPENTANE	4259001	C8H16
143.501	1,2,3-TRIMETHYLCYCLOPENTANE	2613696	C8H16
144	C8H16		C8H16
145	2-OCTENE	111671	C8H16
146	ISOPROPYLCYCLOPENTANE	3875512	C8H16
147	*** UNKNOWN ***		C8H16
148	2,3,5-TRIMETHYLHEXANE	1069530	C9H20
149	C8H14		C8H14
160	2,4-DIMETHYLHEPTANE	2213232	C9H20
161	C8H14		C8H14
162	2,6-DIMETHYLHEPTANE	1072055	C9H20
163	n-PROPYLCYCLOPENTANE	2040962	C8H16
165	2,5-DIMETHYLHEPTANE	2216300	C9H20
165.501	3,5-DIMETHYLHEPTANE	926829	C9H20
165.502	C9H18		C9H18
166	1,1,4-TRIMETHYLCYCLOHEXANE		C9H18
167	C9H18		C9H18
167.501	C9H18		C9H18
167.502	C9H16		C9H16
167.503	C9H18		C9H18
168	ETHYLBENZENE	100414	C8H10
169	2,3-DIMETHYLHEPTANE	3074713	C9H20
170	3,4-DIMETHYLHEPTANE	922281	C9H20
171	M&P-XYLENE		C8H10
174	3-METHYLOCTANE	2216333	C9H20
176	C9H18		C9H18
177	C10H22		C10H22
177.501	STYRENE	100425	C8H8
178	1-NONENE	124118	C9H18
178.501	2-NONENE		C9H18
179	O-XYLENE	95476	C8H10
180	4-NONENE	2198234	C9H18
182	C9H18		C9H18
187	N-NONANE	111842	C9H20
188	C9H18		C9H18
190	C9H18		C9H18
193	C9H18		C9H18
194	C9H18		C9H18
195	ISOPROPYLBENZENE	98828	C9H12
196	C10H22 ?		C10H22
197	C10H22 ?		C10H22
197.501	C10H22 ?		C10H22
198	n-BUTYLCYCLOPENTANE		C9H18
199	C10H22 ?		C10H22
200	C10H22		C10H22
201	C9H18		C9H18
202	C10H22 ?		C10H22
202.501	*** UNKNOWN ***		C10H22
203	C10H20		C10H20
204	N-PROPYLBENZENE	103651	C9H12
206	1-METHYL-3-ETHYLBENZENE	620144	C9H12
207	1-METHYL-4-ETHYLBENZENE	622968	C9H12
209	1,3,5-TRIMETHYLBENZENE	108678	C9H12
210	C10H22		C10H22
211	C10H20		C10H20
212	C10H22		C10H22
212.501	C10H20		C10H20
213	1-METHYL-2-ETHYLBENZENE	611143	C9H12

Appendix A (continued). Speciated Compounds

Compound Number	Compound Name	CAS Number	FORMULA
76.501	2,3-DIMETHYL-2-BUTENE	563791	C6H12
76.502	*** UNKNOWN ***		
77	2,2,3-TRIMETHYLBUTANE	464062	C7H16
78	C6H8		C6H8
79	C7H12		C7H12
79.501	*** UNKNOWN ***		
80	2,4-DIMETHYL-1-PENTENE	2213323	C7H12
80.501	*** UNKNOWN ***		
81	1-METHYLCYCLOPENTENE	693890	C6H10
82	BENZENE	71432	C6H6
83	4,4-DIMETHYL-2-PENTENE	26232984	C7H14
84	3,3-DIMETHYLPENTANE	562492	C7H16
84.501	*** UNKNOWN ***		
85	TRANS-2-METHYL-3-HEXENE	692240	C7H14
86	CYCLOHEXANE	110827	C6H12
88	C7H14		C7H14
89	4-METHYL-1-HEXENE	3769231	C7H14
92	2-METHYLHEXANE	591764	C7H16
93	2,3-DIMETHYLPENTANE	565593	C7H16
94	*** UNKNOWN ***		C7H14
95	1,1-DIMETHYLCYCLOPENTANE	1638262	C7H14
96	3-METHYLHEXANE	58934	C7H16
96.501	CYCLOHEXENE	110838	C6H10
97	TRANS-5-METHYL-2-HEXENE	7385822	C7H14
97.501	*** UNKNOWN ***		
98	CIS-1,3-DIMETHYLCYCLOPENTANE	2532583	C7H14
99	TRANS-1,3-DIMETHYLCYCLOPENTANE	1759586	C7H14
100	TRANS-1,2-DIMETHYLCYCLOPENTANE	822504	C7H14
101	3,4-DIMETHYL-TRANS-2-PENTENE	4914925	C7H14
102	ISO-OCTANE	540841	C8H18
103	3-METHYL-TRANS-3-HEXENE	3899363	C7H14
104	TRANS-3-HEPTENE	14686147	C7H14
105	N-HEPTANE	142825	C7H16
106	CIS-3-METHYL-3-HEXENE	491489	C7H14
108	TRANS-2-HEPTENE	14686136	C7H14
109	3-ETHYL-2-PENTENE	816795	C7H14
109.501	C7H12		C7H12
110	2-METHYL-2-HEXENE	2738194	C7H14
111	1,5-DIMETHYLCYCLOPENTENE	16491159	C7H12
111.5	CIS-2-HEPTENE	6443921	C7H14
111.501	2,3-DIMETHYL-2-PENTENE	10574375	C7H14
112	4-ETHYL CYCLOPENTENE		C7H12
112.5	2,2-DIMETHYLHEXANE	590738	C8H18
112.501	1-CIS-2-DIMETHYLCYCLOPENTANE	1192183	C7H14
113	METYHLCYCLOHEXANE	108872	C7H14
114	1,1,3-TRIMETHYLCYCLOPENTANE		C8H16
115	C8H14		C8H14
118	2,5-DIMETHYLHEXANE	592132	C8H18
119	2,4-DIMETHYLHEXANE	589435	C8H18
119.501	2,2,3-TRIMETHYLPENTANE	564023	C8H18
119.502	3-METHYLCYCLOHEXENE	591480	C7H12
120	1,2,4-TRIMETHYLCYCLOPENTANE	16883480	C8H16
120.501	3,3-DIMETHYLHEXANE	563166	C8H18
121	C8H16		C8H16
122	C8H14		C8H14
123	C,T,C-1,2,3-TRIMETHYLCYCLOPENTANE	15890401	C8H16
124	2,3,4-TRIMETHYLPENTANE	565753	C8H18
125	1-ETHYLCYCLOPENTENE	2146385	C7H12
125.502	2,3,3-TRIMETHYLPENTANE	560214	C8H18
126	TOLUENE	108883	C7H8
127	2,3-DIMETHYLHEXANE	584941	C8H18
127.501	C8H14		C8H14
128	2-METHYLHEPTANE	592278	C8H18
129	4-METHYLHEPTANE	589537	C8H18
130	3,4-DIMETHYLHEXANE	583482	C8H18
131	3-METHYLHEPTANE	589811	C8H18
131.501	3-ETHYLHEXANE	619998	C8H18
132	1,2,4-TRIMETHYLCYCLOPENTANE		C8H16
133	TRANS-1,4-DIMETHYLCYCLOHEXANE	2207047	C8H16
134	1,3-DIMETHYLCYCLOHEXANE		C8H16

Compound Number	Compound Name	CAS Number	FORMULA
214	C10H20		C10H20
215	C10H20		C10H20
216	C10H20		C10H20
217	o-METHYLSTYRENE	100801	C9H10
218	1,2,4-TRIMETHYLBENZENE	95636	C9H12
219	N-DECANE	124185	C10H22
219.5	C10H20		C10H20
219.501	C10H20		C10H20
219.502	*** UNKNOWN ***		
219.503	*** UNKNOWN ***		
220	2-METHYLPROPYLBENZENE	538932	C10H14
221	1-METHYLPROPYLBENZENE	135988	C10H14
222	C11H24		C11H24
222.501	1-METHYL-3-ISOPROPYLBENZENE	535773	C10H14
222.502	C11H24		C11H24
223	1,2,3-TRIMETHYLBENZENE	576738	C10H14
224	C11H24		C11H24
224.501	C10H20		C10H20
224.502	C11H24		C11H24
225	2,3-DIHYDROINDENE(INDAN)	496117	C9H10
225.501	C10H12		C10H12
226	C10H20		C10H20
227	1,3-DIETHYLBENZENE	141935	C10H14
229	1-METHYL-3-n-PROPYLBENZENE	1074437	C10H14
229.501	1-METHYL-4-n-PROPYLBENZENE	1074551	C10H14
230	1,2-DIETHYLBENZENE	135013	C10H14
230.501	n-BUTYLBENZENE	104518	C10H14
230.502	C11H24		C11H24
231	C11H24		C11H24
232	C11H24		C11H24
232.501	1,3-DIMETHYL-5-ETHYLBENZENE		C10H14
233	1-METHYL-2-n-PROPYLBENZENE	1074175	C10H14
233.501	C11H24		C11H24
234	1,4-DIMETHYL-2-ETHYLBENZENE	1758889	C10H14
235	1,3-DIMETHYL-4-ETHYLBENZENE	874419	C10H14
236	1,2-DIMETHYL-4-ETHYLBENZENE	934805	C10H14
236.501	o-ETHYLSTYRENE		C10H12
237	1,3-DIMETHYL-2-ETHYLBENZENE	2870044	C10H14
238	C10H12		C10H12
239	C11H22		C11H22
240	n-UNDECANE	1120214	C11H24
240.501	C10H12		C10H12
241	C11H16		C11H16
241.501	C11H16		C11H16
242	1,2-DIMETHYL-3-ETHYLBENZENE		C10H14
243	C11H14		C11H14
243.501	C12H26		C12H26
245	1,2,4,5-TETRAMETHYLBENZENE	95932	C10H14
246	1,2,3,5-TETRAMETHYLBENZENE	527537	C10H14
247	C12H26		C12H26
247.501	*** UNKNOWN ***		
249	C11H16		C11H16
250	C11H16		C11H16
252	C11H16		C11H16
255	C10H12		C10H12
256	C11H16	5161046	C11H16
257	1-METHYL-1H-INDENE	767599	C10H10
258	C10H12		C10H12
259	C11H16		C11H16
260	C11H16		C11H16
261	C11H16		C11H16
262	C10H12		C10H12
263	C11H16		C11H16
263.501	*** UNKNOWN ***		
265	C11H14		C11H14
267	*** UNKNOWN ***		C11H16
268	NAPHTHALENE	91203	C10H8
268.501	C11H14		C11H14
269	n-DODECANE	112403	C12H26
330	MTBE	1634044	C5H12O
340	METHANOL	67561	CH4O

Appendix B. Dodge Spirit Emissions Data

1993 FFV DODGE SPIRIT - M50 TESTS AT LAB 1

NREL VEH ID	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
AR202MS	11/21/94	6199	M50	17.68	1.280	359.9	0.086	0.060	0.107	0.091	0.104	0.636
AR205MS	12/05/94	4558	M50	17.43	1.650	364.5	0.095	0.070	0.122	0.101	0.118	0.946
AR206MS	11/18/94	6709	M50	17.355	1.120	367.1	0.074	0.290	0.094	0.080	0.091	0.912
AR209MS	11/10/94	6372	M50	17.56	1.470	362.2	0.083	0.050	0.105	0.087	0.101	1.093
AR210MS	11/09/94	9614	M50	18.04	2.480	351.1	0.094	0.245	0.190	0.106	0.177	0.483
AR212MS	11/15/94	7719	M50	17.08	1.460	373.0	0.079	0.310	0.102	0.085	0.098	0.740
DT203MS	03/23/94	4654	M50	16.64	1.750	380.7	0.115	0.070	0.143	0.124	0.139	0.959
DT208MS	05/09/94	11096	M50	17.42	1.660	363.7	0.103	0.230	0.131	0.109	0.126	0.945
DT211MS	05/23/94	4800	M50	17.165	1.050	370.1	0.085	0.365	0.111	0.090	0.105	0.785
DT212MS	03/28/94	4373	M50	17.83	1.010	356.3	0.079	0.140	0.100	0.086	0.096	0.858
DT219MS	06/03/94	16953	M50	17.3	1.230	366.9	0.096	0.170	0.122	0.103	0.115	1.364
DT221MS	05/02/94	11552	M50	17.94	1.180	353.8	0.089	0.170	0.113	0.096	0.108	0.603
DT223MS	03/14/94	9838	M50	17.627	1.387	359.8	0.106	0.077	0.130	0.114	0.126	3.242
DT225MS	03/31/94	8838	M50	16.74	1.830	378.2	0.088	0.150	0.116	0.096	0.111	0.854
DT226MSC	06/13/94	15403	M50	17.395	1.240	364.8	0.105	0.375	0.138	0.112	0.131	1.181
DT229MS	04/13/94	9879	M50	17.315	0.955	367.0	0.072	0.375	0.098	0.078	0.093	0.970
DT230MS	05/23/94	5934	M50	17.19	1.490	368.7	0.095	0.070	0.120	0.100	0.114	0.795
DT233MS	03/08/94	4283	M50	17.2	1.090	369.3	0.096	0.060	0.119	0.104	0.114	0.984
DT235MS	03/22/94	4582	M50	17.17	1.220	369.7	0.080	0.100	0.103	0.087	0.099	0.988
DT238MS	05/04/94	12356	M50	17.36	1.510	365.1	0.113	0.370	0.148	0.121	0.142	0.942
DT241MS	03/29/94	4034	M50	19.03	0.950	333.8	0.077	0.250	0.100	0.083	0.096	0.343
DT245MS	05/25/94	3783	M50	16.47	0.925	386.4	0.077	0.280	0.099	0.082	0.094	1.179
DT250MS	06/06/94	9471	M50	17.41	0.840	365.2	0.078	0.230	0.101	0.085	0.096	0.761
DT251MSC	06/01/94	18170	M50	17.13	1.860	369.5	0.121	0.100	0.151	0.127	0.144	1.201
DT252MS	03/30/94	9145	M50	17.065	2.170	370.4	0.103	0.200	0.137	0.110	0.131	0.888
			COUNT	25	25	25.0	25.000	25.000	25.000	25.000	25.000	25.000
			AVERAGE	17.38	1.39	365.5	0.091	0.192	0.120	0.098	0.115	0.986
			STD DEV	0.49	0.40	10.0	0.013	0.110	0.022	0.014	0.020	0.512
			CV	0.03	0.29	0.0	0.147	0.574	0.182	0.144	0.178	0.519

1993 FFV DODGE SPIRIT - M50 TESTS AT LAB 2

NREL VEH ID	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
DC203MS	06/27/94	9856	M50	16.90	1.279	382.609	0.078	0.185	0.116	0.101	0.104	0.331
DC209MS	05/18/95	11044	M50	16.28	1.683	397.473	0.090	0.081	0.122	0.105	0.117	0.502
DC210MS	12/14/94	11294	M50	16.00	1.656	404.269	0.101	0.307	0.138	0.113	0.132	0.364
DC211MS	12/06/94	6903	M50	16.16	1.100	400.616	0.091	0.564	0.127	0.104	0.120	0.203
DC213MS	07/13/94	4543	M50	16.15	1.336	400.843	0.062	0.126	0.088	0.072	0.084	0.220
DC215MS	09/07/94	12926	M50	17.11	1.571	377.716	0.074	0.210	0.101	0.083	0.097	0.399
DC216MS	07/21/94	9544	M50	16.89	1.449	382.584	0.083	0.104	0.115	0.099	0.107	0.244
DC217MS	05/23/94	12623	M50	16.80	2.724	382.733	0.122	0.107	0.144	0.121	0.154	0.296
DC218MS	07/25/94	13556	M50	17.01	1.658	379.531	0.096	0.251	0.132	0.111	0.124	0.281
DC238MS	12/08/94	22579	M50	15.66	3.365	409.515	0.137	0.157	0.182	0.150	0.175	0.524
DC239MS	09/14/94	13514	M50	16.28	2.363	395.899	0.096	0.140	0.139	0.115	0.129	0.282
DC241MSC	07/13/94	19597	M50	17.21	2.022	374.780	0.085	0.144	0.122	0.095	0.117	0.452
DC242MS	01/12/95	6612	M50	16.43	1.260	393.539	0.085	0.236	0.117	0.097	0.111	0.299
DC243MS	01/17/95	7103	M50	16.38	1.570	394.970	0.061	0.139	0.089	0.072	0.084	0.426
DC244MSC	12/23/94	15350	M50	16.39	2.464	393.194	0.100	0.085	0.136	0.115	0.129	0.293
DC245MSC	11/23/94	5517	M50	15.87	1.271	407.947	0.077	0.180	0.104	0.092	0.096	
DC246MS	11/30/94	4881	M50	15.85	0.913	408.865	0.074	0.268	0.102	0.088	0.100	0.149
DC248MSC	12/16/94	16007	M50	16.37	2.138	394.066	0.103	0.124	0.138	0.121	0.130	0.455
DC249MSC	08/30/94	10027	M50	16.25	1.464	397.522	0.125	0.102	0.159	0.141	0.151	0.448
DC258MS	12/14/94	8321	M50	15.82	1.453	409.022	0.074	0.091	0.105	0.094	0.095	0.221
DC259MS	07/07/94	6581	M50	16.61	1.771	388.648	0.070	0.073	0.100	0.084	0.092	0.184
DC260MS	12/19/94	7701	M50	16.19	1.880	399.492	0.076	0.077	0.102	0.085	0.098	0.279
DC262MS	12/06/94	8275	M50	15.81	1.695	408.527	0.077	0.105	0.109	0.090	0.101	0.326
DC263MS	11/28/94	5150	M50	16.13	1.593	400.862	0.092	0.089	0.119	0.106	0.115	0.604
			COUNT	24	24	24	24	24	24	24	24	23
			AVERAGE	16.36	1.737	395.217	0.089	0.164	0.121	0.102	0.115	0.338
			STD DEV	0.43	0.542	10.449	0.019	0.105	0.022	0.019	0.022	0.117
			CV	0.03	0.312	0.026	0.211	0.640	0.180	0.184	0.195	0.345

Appendix B. Dodge Spirit Emissions Data

1993 FFV DODGE SPIRIT - M50 TESTS AT LAB 3

NREL	TEST	TEST	TEST	Exhaust Emissions (g/mi)							Exhaust	Evap
VEH ID	DATE	ODOM	FUEL	MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	HC(total)	HC(total)
DV205MS	06/03/94	9673	M50	19.763	1.781	341.625	0.090	0.543	0.146	0.117	0.119	0.336
DV206MS	08/22/94	10015	M50	19.114	1.462	353.913	0.072	0.274	0.113	0.090	0.095	0.405
DV207MS	05/06/94	4071	M50	18.767	2.108	359.436	0.089	0.075	0.135	0.113	0.110	0.231
DV208MS	04/15/94	9826	M50	18.634	1.977	362.646	0.080	0.116	0.120	0.099	0.101	0.414
DV209MS	04/22/94	6556	M50	19.166	1.652	352.637	0.075	0.099	0.113	0.094	0.094	0.241
DV211MS	09/14/94	21332	M50	19.861	1.559	340.318	0.082	0.164	0.122	0.102	0.102	0.694
DV212MS	08/05/94	10982	M50	19.45	2.088	346.720	0.078	0.554	0.139	0.110	0.107	0.227
DV220MS	12/07/94	17402	M50	19.967	1.604	338.403	0.090	0.253	0.126	0.108	0.108	0.291
DV226MS	08/09/94	10000	M50	19.655	1.501	344.043	0.068	0.131	0.113	0.094	0.087	0.599
DV227MS	05/03/94	5336	M50	19.423	1.343	348.421	0.064	0.378	0.108	0.085	0.087	0.198
DV229MS	07/20/94	23077	M50	19.706	2.129	342.068	0.103	0.371	0.154	0.125	0.132	0.487
DV230MS	12/13/94	18987	M50	19.717	1.669	342.604	0.100	0.332	0.144	0.123	0.121	0.469
DV231MS	07/17/94	22082	M50	19.496	3.226	344.033	0.107	0.208	0.176	0.142	0.141	0.189
DV233MS	06/22/94	20413	M50	19.488	2.087	346.030	0.083	0.281	0.140	0.111	0.111	0.305
DV242MS	06/17/94	4175	M50	19.246	1.087	352.077	0.060	0.376	0.103	0.082	0.082	0.741
DV244MS	09/07/94	9988	M50	19.773	1.850	341.358	0.093	0.091	0.144	0.124	0.113	0.316
DV246MS	06/30/94	8897	M50	20.265	1.738	333.286	0.091	0.160	0.142	0.119	0.115	0.308
DV248MS	07/26/94	9326	M50	19.395	1.616	348.497	0.066	0.161	0.109	0.085	0.089	0.424
DV249MS	02/03/95	13274	M50	19.959	1.578	338.612	0.122	0.213	0.124	0.100	0.098	0.634
DV251MS	11/01/94	24469	M50	19.888	2.337	338.577	0.111	0.139	0.159	0.146	0.125	0.477
DV257MS	10/27/94	26126	M50	19.682	2.149	342.476	0.056	0.287	0.135	0.078	0.114	0.331
DV258MS	11/18/94	24128	M50	19.544	1.682	345.632	0.101	0.253	0.143	0.121	0.123	0.693
			COUNT	22	22	22	22	22	22	22	22	22
			AVERAGE	19.54	1.828	345.610	0.086	0.248	0.132	0.108	0.108	0.410
			STD DEV	0.38	0.426	6.940	0.017	0.132	0.018	0.018	0.015	0.167
			CV	0.02	0.233	0.020	0.200	0.533	0.139	0.169	0.141	0.408

1993 FFV DODGE SPIRIT - M85 TESTS AT LAB 1

NREL	TEST	TEST	TEST	Exhaust Emissions (g/mi)							Exhaust	Evap
VEH ID	DATE	ODOM	FUEL	MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	HC(total)	HC(total)
AR202MS	11/18/94	6166	M85	13.89	1.240	346.600	0.072	0.070	0.096	0.087	0.091	0.417
AR205MS	12/07/94	4592	M85	13.78	1.440	349.100	0.075	0.050	0.102	0.091	0.097	0.564
AR206MS	11/21/94	6735	M85	13.78	1.390	349.000	0.076	0.100	0.100	0.090	0.095	0.530
AR209MS	11/07/94	6305	M85	13.87	1.780	346.200	0.074	0.040	0.100	0.087	0.095	0.540
AR210MS	11/10/94	9640	M85	13.78	1.260	349.400	0.070	0.140	0.100	0.085	0.093	0.360
AR212MS	11/09/94	7648	M85	13.83	1.750	347.200	0.081	0.180	0.110	0.097	0.104	0.599
DT203MS	03/22/94	4620	M85	12.86	2.090	368.200	0.116	0.040	0.154	0.142	0.147	0.576
DT208MS	05/05/94	11028	M85	13.67	1.970	350.900	0.127	0.280	0.170	0.154	0.163	0.527
DT211MS	05/24/94	4826	M85	13.59	1.080	349.900	0.081	0.280	0.108	0.096	0.100	0.615
DT212MS	03/25/94	4339	M85	13.86	1.120	343.000	0.086	0.110	0.115	0.106	0.109	0.348
DT219MS	06/13/94	17116	M85	13.61	1.160	349.200	0.086	0.260	0.117	0.102	0.108	0.755
DT221MS	05/03/94	11588	M85	13.84	1.050	343.500	0.078	0.210	0.105	0.095	0.098	0.486
DT223MS	03/09/94	9779	M85	13.80	1.190	344.350	0.087	0.065	0.118	0.108	0.111	1.688
DT225MS	04/06/94	8897	M85	13.45	2.945	352.700	0.105	0.430	0.147	0.129	0.139	0.654
DT226MSC	06/03/94	15325	M85	13.64	1.220	348.450	0.085	0.410	0.120	0.103	0.110	0.873
DT229MS	03/28/94	9762	M85	13.53	1.080	351.400	0.071	0.210	0.098	0.088	0.092	0.530
DT230MS	05/24/94	5973	M85	13.45	1.300	353.200	0.091	0.110	0.116	0.104	0.110	0.459
DT233MS	03/07/94	4249	M85	13.42	1.255	354.150	0.097	0.050	0.127	0.117	0.121	1.508
DT235MS	03/21/94	4549	M85	13.27	1.550	357.500	0.119	0.110	0.158	0.145	0.150	0.714
DT238MS	04/29/94	12296	M85	13.50	1.820	350.950	0.111	0.360	0.155	0.136	0.145	0.678
DT241MS	04/07/94	4134	M85	13.37	1.095	355.750	0.076	0.345	0.109	0.097	0.102	0.325
DT245MS	05/20/94	3730	M85	13.31	1.000	357.550	0.076	0.310	0.120	0.110	0.099	0.870
DT250MS	06/03/94	9445	M85	13.60	1.240	349.250	0.083	0.290	0.112	0.099	0.103	0.441
DT251MSC	06/02/94	18203	M85	13.45	1.320	353.200	0.086	0.100	0.114	0.102	0.104	0.859
DT252MS	04/04/94	9204	M85	13.33	1.220	356.400	0.078	0.280	0.120	0.115	0.108	1.007
			COUNT	25	25	25	25	25	25	25	25	33
			AVERAGE	13.58	1.423	351.082	0.087	0.193	0.120	0.107	0.112	0.726
			STD DEV	0.24	0.428	5.294	0.016	0.121	0.020	0.019	0.020	0.455
			CV	0.02	0.301	0.015	0.180	0.626	0.171	0.179	0.179	0.627

1993 FFV DODGE SPIRIT - M85 TESTS AT LAB 2

NREL VEH ID	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
DC203MS	06/28/94	9889	M85	12.87	1.458	373.893	0.027	0.087	0.098	0.088	0.037	0.519
DC209MS	05/19/94	5797	M85	12.90	1.733	372.585	0.046	0.069	0.122	0.113	0.056	
DC210MS	12/16/94	11361	M85	12.39	2.201	387.199	0.069	0.297	0.187	0.169	0.087	0.406
DC211MS	12/05/94	6870	M85	12.49	1.644	384.555	0.040	0.309	0.166	0.152	0.054	0.178
DC213MS	07/11/94	4475	M85	12.27	1.692	391.739	0.032	0.098	0.114	0.103	0.043	0.173
DC215MS	09/09/94	12977	M85	12.40	2.251	386.797	0.030	0.191	0.109	0.096	0.042	0.301
DC216MS	07/22/94	9578	M85	12.87	1.866	372.823	0.031	0.090	0.129	0.118	0.042	0.256
DC217MS	05/27/94	12750	M85	13.18	1.816	364.421	0.042	0.120	0.127	0.114	0.056	
DC218MS	07/22/94	13522	M85	13.06	1.723	367.603	0.030	0.278	0.126	0.112	0.044	0.296
DC238MS	12/12/94	22646	M85	11.94	2.671	401.266	0.055	0.173	0.175	0.156	0.074	0.485
DC239MS	09/13/94	13480	M85	12.40	2.848	386.280	0.051	0.138	0.135	0.120	0.066	0.298
DC241MSC	07/15/94	19664	M85	13.37	1.942	359.302	0.037	0.158	0.129	0.116	0.050	0.529
DC242MS	01/11/95	6578	M85	12.63	1.499	380.557	0.037	0.224	0.128	0.115	0.050	0.336
DC243MS	01/18/95	7136	M85	12.45	1.883	385.970	0.021	0.118	0.113	0.102	0.033	0.318
DC244MSC	12/22/94	15317	M85	12.52	2.252	383.432	0.043	0.091	0.135	0.122	0.056	0.303
DC245MSC	11/22/94	5484	M85	12.17	1.804	394.528	0.039	0.134	0.128	0.118	0.049	0.165
DC246MS	12/02/94	4948	M85	12.12	1.444	397.069	0.039	0.151	0.141	0.131	0.049	
DC248MSC	12/15/94	15973	M85	12.51	2.460	382.786	0.040	0.153	0.127	0.115	0.052	0.363
DC249MSC	09/01/94	10097	M85	12.76	1.391	376.864	0.050	0.106	0.155	0.144	0.062	0.302
DC258MS	12/12/94	8254	M85	12.05	2.293	397.973	0.040	0.090	0.114	0.102	0.051	0.222
DC259MS	07/06/94	6548	M85	12.82	2.197	374.094	0.040	0.073	0.117	0.105	0.052	0.131
DC260MS	12/22/94	7781	M85	12.41	2.034	387.472	0.042	0.087	0.125	0.114	0.052	0.255
DC262MS	12/07/94	8313	M85	12.36	1.729	389.258	0.026	0.103	0.113	0.104	0.036	0.301
DC263MS	11/29/94	5184	M85	12.10	1.974	396.921	0.040	0.090	0.152	0.141	0.051	0.123
			COUNT	24	24	24	24	24	24	24	24	22
			AVERAGE	12.54	1.950	383.141	0.039	0.143	0.132	0.120	0.052	0.313
			STD DEV	0.36	0.376	10.866	0.010	0.069	0.021	0.020	0.012	0.130
			CV	0.03	0.193	0.028	0.258	0.482	0.159	0.164	0.226	0.415

1993 FFV DODGE SPIRIT - M85 TESTS AT LAB 3

NREL VEH ID	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
DV205MS	06/02/94	9647	M85	12.78	1.236	331.819	0.040	0.456	0.122	0.103	0.060	0.247
DV206MS	08/16/94	9921	M85	12.67	1.530	334.392	0.054	0.240	0.122	0.106	0.069	0.431
DV207MS	05/24/94	4138	M85	12.45	1.546	340.195	0.049	0.050	0.121	0.109	0.061	0.197
DV208MS	04/19/94	9859	M85	12.47	1.378	339.959	0.044	0.126	0.121	0.108	0.057	0.293
DV209MS	04/28/94	6641	M85	12.49	1.601	338.977	0.050	0.119	0.112	0.100	0.062	0.418
DV211MS	09/13/94	21298	M85	12.94	1.924	326.657	0.051	0.151	0.137	0.121	0.067	0.757
DV212MS	08/03/94	10922	M85	12.61	1.555	335.767	0.033	0.539	0.119	0.100	0.052	0.165
DV220MS	12/06/94	17369	M85	12.94	1.304	327.577	0.056	0.274	0.127	0.114	0.069	0.253
DV226MS	08/11/94	10067	M85	12.84	2.200	328.739	0.012	0.107	0.102	0.087	0.026	0.509
DV227MS	04/29/94	5295	M85	12.48	1.080	340.150	0.042	0.253	0.090	0.080	0.052	0.222
DV229MS	07/22/94	23129	M85	12.76	1.896	331.393	0.054	0.374	0.157	0.139	0.071	0.354
DV230MS	12/14/94	19021	M85	12.93	2.240	326.251	0.060	0.256	0.152	0.136	0.076	0.395
DV231MS	07/14/94	22041	M85	12.72	2.674	331.132	0.039	0.190	0.147	0.124	0.062	0.285
DV233MS	06/21/94	20380	M85	12.67	1.642	334.204	0.014	0.293	0.107	0.089	0.032	0.267
DV242MS	02/08/95	8746	M85	12.74	1.111	333.109	0.033	0.231	0.109	0.096	0.049	0.596
DV244MS	09/09/94	10055	M85	12.89	1.526	328.566	0.077	0.096	0.155	0.144	0.088	0.357
DV246MS	06/28/94	8838	M85	13.16	1.235	322.181	0.050	0.245	0.129	0.113	0.066	0.243
DV248MS	07/22/94	9292	M85	12.67	2.130	333.351	0.042	0.134	0.131	0.111	0.062	0.425
DV249MS	02/02/95	13241	M85	12.88	2.021	327.886	0.046	0.248	0.127	0.110	0.065	0.778
DV251MS	11/02/94	24502	M85	13.04	1.962	324.127	0.070	0.184	0.162	0.152	0.080	0.247
DV257MS	10/25/94	26058	M85	12.90	1.431	328.338	0.052	0.193	0.124	0.116	0.060	0.213
DV258MS	12/01/94	24187	M85	13.13	1.703	322.183	0.062	0.210	0.134	0.121	0.075	0.646
			COUNT	22	22	22	22	22	22	22	22	22
			AVERAGE	12.78	1.678	331.225	0.047	0.226	0.127	0.113	0.062	0.377
			STD DEV	0.20	0.40	5.4	0.015	0.114	0.018	0.018	0.014	0.175
			CV	0.02	0.24	0.0	0.320	0.503	0.143	0.160	0.223	0.464

1993 STANDARD DODGE SPIRIT - RFG TESTS AT LAB 1

NREL	TEST	TEST	TEST	Exhaust Emissions (g/mi)							Exhaust	Evap
VEH ID	DATE	ODOM	FUEL	MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	HC(total)	HC(total)
DT201GSC	05/12/94	17018	RFG	24.44	1.150	356.200	0.073	0.270			0.083	0.664
DT202GSC	06/27/94	20800	RFG	24.61	1.340	353.300	0.084	0.260			0.095	0.328
DT203GSC	06/22/94	8831	RFG	23.70	0.940	367.700	0.061	0.180			0.069	0.340
DT204GSC	05/13/94	5647	RFG	23.65	0.830	368.700	0.071	0.220			0.078	0.330
DT205GSC	12/16/94	11388	RFG	24.17	1.410	359.700	0.089	0.270			0.103	0.243
DT206GSC	07/01/94	7706	RFG	24.05	0.800	362.500	0.066	0.210			0.074	0.206
DT207GSC	12/19/94	35784	RFG	24.78	1.255	351.000	0.086	0.425			0.097	0.243
DT208GSC	05/13/94	10225	RFG	24.31	0.740	358.700	0.071	0.280			0.080	0.305
DT209GSC	04/20/94	8362	RFG	23.91	1.200	364.000	0.077	0.220			0.086	0.259
DT210GSC	07/06/94	19143	RFG	24.91	1.470	348.700	0.120	0.545			0.134	0.216
DT211GSC	03/21/94	4339	RFG	23.57	1.480	368.800	0.082	0.120			0.091	0.381
DT212GSC	06/28/94	4923	RFG	24.02	0.930	362.800	0.068	0.150			0.078	0.265
DT213GSC	07/01/94	6547	RFG	24.09	0.900	361.700	0.070	0.200			0.080	0.289
DT214GSC	05/10/94	10659	RFG	24.38	0.620	357.950	0.060	0.325			0.066	0.275
DT215GSC	04/21/94	12278	RFG	24.37	1.390	356.800	0.078	0.280			0.088	0.278
DT216GSC	03/08/94	11204	RFG	23.70	1.840	366.150	0.089	0.265			0.103	0.362
DT217GSC	04/25/94	20294	RFG	24.49	1.635	354.650	0.084	0.315			0.095	0.340
DT218GSC	06/23/94	12419	RFG	24.40	1.325	356.450	0.077	0.305			0.088	0.173
DT219GSC	05/12/94	11700	RFG	24.24	0.820	359.700	0.073	0.240			0.081	0.208
DT221GSC	04/22/94	8994	RFG	24.53	1.120	354.800	0.071	0.220			0.081	0.230
DT222GSC	06/23/94	20051	RFG	24.65	1.740	352.100	0.084	0.250			0.097	0.239
DT223GSC	12/22/94	10667	RFG	24.08	1.130	361.600	0.075	0.210			0.086	0.283
DT224GSC	03/03/94	11396	RFG	23.43	1.170	371.500	0.079	0.220			0.089	0.317
DT225GSC	05/18/94	13037	RFG	23.87	1.420	364.200	0.094	0.190			0.107	0.299
DT226GSC	06/27/94	5138	RFG	23.94	0.700	364.300	0.063	0.240			0.071	0.332
			COUNT	25	25	25	25	25			25	25
			AVERAGE	24.17	1.174	360.160	0.078	0.256			0.088	0.296
			STD DEV	0.38	0.327	5.894	0.012	0.084			0.014	0.091
			CV	0.02	0.279	0.016	0.158	0.328			0.160	0.309

1993 STANDARD DODGE SPIRIT - RFG TESTS AT LAB 2

NREL	TEST	TEST	TEST	Exhaust Emissions (g/mi)							Exhaust	Evap
VEH ID	DATE	ODOM	FUEL	MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	HC(total)	HC(total)
DC201GSC	08/17/94	4001	RFG	22.36	1.196	394.471	0.074	0.301			0.083	0.070
DC202GSC	02/16/95	11486	RFG	22.38	2.110	392.059	0.098	0.221			0.116	0.134
DC203GSC	09/06/94	7805	RFG	24.11	1.269	364.531	0.094	0.223			0.105	0.078
DC204GSC	01/04/95	17048	RFG	22.71	2.346	386.416	0.090	0.342			0.105	0.099
DC205GSC	07/27/94	4173	RFG	22.53	1.224	390.903	0.068	0.218			0.078	0.100
DC206GSC	02/01/95	22770	RFG	22.01	2.002	398.796	0.078	0.230			0.091	0.158
DC207GSC	01/20/95	9012	RFG	22.28	1.971	394.073	0.094	0.257			0.109	0.119
DC208GSC	01/30/95	22955	RFG	22.46	2.512	389.537	0.090	0.521			0.107	0.109
DC209GSC	01/31/95	4967	RFG	22.08	1.178	399.082	0.061	0.406			0.072	0.134
DC210GSC	06/21/94	3844	RFG	22.59	1.122	390.460	0.059	0.210			0.067	0.114
DC211GSC	04/05/95	10984	RFG	22.67	1.538	387.859	0.067	0.278			0.079	0.103
DC212GSC	08/29/94	9026	RFG	22.53	1.720	389.706	0.090	0.237			0.103	0.148
DC213GSC	06/21/94	31884	RFG	23.10	1.940	380.152	0.082	0.387			0.094	0.158
DC214GSC	12/20/94	9242	RFG	21.06	3.324	415.352	0.093	0.604			0.113	0.196
DC215GSC	07/12/94	11429	RFG	23.28	1.956	376.816	0.085	0.413			0.099	0.069
DC220GSC	06/07/94	4729	RFG	23.28	1.366	378.068	0.075	0.252			0.085	0.062
DC221GSC	06/07/94	10603	RFG	23.33	1.541	376.942	0.069	0.246			0.080	0.088
DC222GSC	01/26/95	4582	RFG	22.59	1.114	390.441	0.085	0.389			0.086	0.165
DC223GSC	07/07/94	3455	RFG	21.89	1.495	401.663	0.074	0.201			0.085	0.127
DC224GSC	01/20/95	6612	RFG	22.05	1.529	399.459	0.090	0.237			0.105	0.180
DC225GSC	02/11/95	18081	RFG	21.97	4.233	395.697	0.136	0.258			0.155	0.140
DC226GSC	06/27/94	5327	RFG	23.30	1.196	378.332	0.060	0.301			0.070	0.105
			COUNT	22	22	22	22	22			22	24
			AVERAGE	22.57	1.813	389.582	0.082	0.306			0.095	0.117
			STD DEV	0.64	0.751	10.628	0.017	0.105			0.019	0.038
			CV	0.03	0.414	0.027	0.202	0.342			0.205	0.321

1993 FFV DODGE SPIRIT - RFG TESTS AT LAB 2

NREL VEH ID	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
DC203MS	06/29/94	9934	RFG	21.98	1.663	400.313	0.106	0.079			0.123	0.747
DC209MS	05/16/94	5697	RFG	22.02	2.309	398.024	0.140	0.077			0.162	0.195
DC210MS	12/15/94	11328	RFG	21.34	1.556	412.348	0.131	0.211			0.159	0.295
DC211MS	12/07/94	6936	RFG	20.99	1.523	418.610	0.120	0.427			0.145	0.280
DC213MS	07/12/94	4509	RFG	21.48	1.290	409.965	0.093	0.112			0.112	0.173
DC215MS	09/06/94	12892	RFG	22.33	1.424	394.344	0.094	0.183			0.115	0.374
DC216MS	07/20/94	9511	RFG	21.75	2.387	403.482	0.127	0.086			0.153	0.256
DC218MS	07/26/94	13589	RFG	21.14	1.530	415.679	0.132	0.206			0.153	0.401
DC238MS	12/09/94	22612	RFG	20.50	4.613	423.920	0.231	0.225			0.278	0.393
DC239MS	09/16/94	13572	RFG	21.47	2.501	408.076	0.176	0.124			0.204	0.317
DC241MSC	07/14/94	19630	RFG	22.55	1.539	389.522	0.106	0.161			0.132	0.424
DC242MS	01/06/95	6544	RFG	21.43	1.250	411.306	0.106	0.205			0.126	0.334
DC243MS	01/14/95	7061	RFG	21.63	1.354	407.113	0.109	0.182			0.131	0.364
DC244MSC	12/21/94	15283	RFG	21.43	1.797	410.122	0.122	0.105			0.145	0.322
DC245MSC	11/21/94	5450	RFG	21.10	1.445	417.027	0.110	0.099			0.129	0.175
DC246MS	12/01/94	4914	RFG	20.58	1.284	427.989	0.100	0.196			0.115	0.114
DC248MSC	12/20/94	16040	RFG	21.73	2.599	402.598	0.132	0.119			0.155	0.421
DC249MSC	08/31/94	10062	RFG	21.48	1.241	410.220	0.118	0.114			0.135	0.321
DC258MS	12/13/94	8288	RFG	20.69	1.733	425.151	0.100	0.084			0.116	0.198
DC259MS	07/01/94	6514	RFG	21.80	1.756	403.318	0.117	0.057			0.136	0.142
DC260MS	12/21/94	7742	RFG	21.18	1.753	415.176	0.097	0.074			0.113	0.252
DC262MS	12/05/94	8241	RFG	20.32	2.166	431.837	0.105	0.085			0.128	0.299
			COUNT	22	22	22	22	22			22	22
			AVERAGE	21.41	1.851	410.734	0.121	0.146			0.144	0.309
			STD DEV	0.56	0.727	10.569	0.030	0.081			0.036	0.131
			CV	0.03	0.393	0.026	0.248	0.552			0.251	0.423

1993 FFV DODGE SPIRIT - RFG TESTS AT LAB 3

NREL VEH ID	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
DV205MS	05/27/94	9587	RFG	24.01	1.524	358.300	0.145	0.200	0.173	0.148	0.170	0.485
DV206MS	08/19/94	9988	RFG	23.34	1.091	369.590	0.106	0.480	0.137	0.109	0.134	0.456
DV207MS	05/10/94	4104	RFG	23.20	2.174	369.717	0.224	0.101	0.260	0.227	0.257	0.302
DV208MS	04/13/94	9782	RFG	25.80	1.336	336.128	0.096	0.080	0.117	0.099	0.115	0.411
DV209MS	04/27/94	6615	RFG	23.48	1.568	365.974	0.284	0.093	0.318	0.287	0.316	0.220
DV211MS	09/16/94	21366	RFG	24.01	1.830	357.876	0.157	0.121	0.184	0.160	0.181	0.627
DV212MS	08/04/94	10948	RFG	23.19	1.886	370.468	0.149	0.546	0.187	0.153	0.184	0.214
DV220MS	12/15/94	17436	RFG	24.67	1.247	349.212	0.128	0.224	0.151	0.130	0.148	0.368
DV226MS	08/10/94	10033	RFG	24.35	2.172	352.202	0.162	0.104	0.194	0.165	0.191	0.733
DV227MS	05/04/94	5369	RFG	23.53	1.745	365.057	0.259	0.099	0.293	0.262	0.290	0.246
DV229MS	07/14/94	23026	RFG	24.30	1.833	353.478	0.168	0.312	0.205	0.172	0.201	0.440
DV230MS	12/20/94	19054	RFG	24.19	1.757	355.307	0.141	0.227	0.170	0.144	0.167	0.459
DV231MS	07/13/94	22015	RFG	24.07	3.548	353.996	0.191	0.211	0.244	0.194	0.240	0.259
DV233MS	06/17/94	20346	RFG	23.20	2.290	369.676	0.142	0.206	0.179	0.146	0.176	0.358
DV242MS	02/10/95	8791	RFG	23.81	1.246	362.062	0.125	0.206	0.136	0.114	0.134	1.027
DV244MS	09/08/94	10021	RFG	23.82	2.552	359.604	0.148	0.111	0.185	0.151	0.182	0.481
DV246MS	07/06/94	8948	RFG	24.17	2.295	353.510	0.515	0.181	0.586	0.518	0.583	0.318
DV248MS	07/28/94	9386	RFG	23.87	2.494	358.736	0.174	0.153	0.218	0.177	0.215	0.530
DV249MS	02/01/95	13207	RFG	24.48	1.774	351.139	0.180	0.186	0.153	0.125	0.150	0.682
DV251MS	11/03/94	24535	RFG	24.57	2.141	349.044	0.183	0.181	0.204	0.185	0.201	0.531
DV257MS	10/26/94	26092	RFG	24.77	1.705	347.047	0.139	0.139	0.156	0.142	0.153	0.303
DV258MS	10/20/94	23696	RFG	24.54	2.078	348.467	0.518	0.166	0.558	0.522	0.554	0.595
			COUNT	22	22	22	22	22	22	22	22	22
			AVERAGE	24.06	1.922	357.118	0.197	0.197	0.228	0.197	0.225	0.457
			STD DEV	0.61	0.532	8.714	0.110	0.115	0.119	0.112	0.119	0.190
			CV	0.03	0.277	0.024	0.559	0.584	0.524	0.567	0.531	0.417

FFV FORD ECONLINE VAN - M50 TESTS AT LAB 2

NREL VEH ID	MODEL YEAR	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
DC301ME	1992	1/31/95	17293	M50	10.96	1.610	591.8	0.110	0.677	0.205	0.147	0.167	0.457
DC302ME	1993	2/14/95	13342	M50	10.53	1.416	616.4	0.124	0.612	0.218	0.168	0.174	0.297
DC303ME	1993	2/17/95	28218	M50	10.85	2.378	595.9	0.131	0.695	0.236	0.181	0.187	0.301
DC304ME	1992	3/30/95	18076	M50	10.93	1.654	593.1	0.097	0.590	0.201	0.144	0.154	0.327
DC305ME	1992	2/9/95	23883	M50	10.16	1.937	638.1	0.118	0.600	0.224	0.171	0.171	0.295
DC306ME	1993	5/11/95	12890	M50	10.98	2.046	588.8	0.181	0.814	0.314	0.243	0.252	0.139
DC307ME	1992	4/28/95	13658	M50	11.07	1.227	585.9	0.084	0.671	0.168	0.116	0.137	0.293
DC308ME	1992	8/22/94	10352	M50	11.42	1.868	567.4	0.125	0.682	0.224	0.161	0.188	0.282
				COUNT	8	8	8	8	8	8	8	8	8
				AVERAGE	10.86	1.767	597.2	0.121	0.668	0.224	0.166	0.179	0.299
				STD DEV	0.352	0.343	19.919	0.027	0.067	0.039	0.035	0.032	0.080
				CV	0.032	0.194	0.033	0.222	0.101	0.175	0.209	0.178	0.269

FFV FORD ECONLINE VAN - M50 TESTS AT LAB 3

NREL VEH ID	MODEL YEAR	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
DV301ME	1992	04/05/95	20548	M50	10.65	2.430	635.4	0.139	0.463	0.228	0.165	0.203	0.374
DV304ME	1992	11/10/94	12902	M50	11.90	1.760	569.5	0.129	0.792	0.184	0.143	0.170	0.188
DV305ME	1992	05/03/95	19692	M50	12.31	2.116	549.5	0.090	0.888	0.178	0.120	0.147	0.127
DV306ME	1992	08/17/94	5141	M50	11.85	2.181	571.0	0.112	0.623	0.179	0.121	0.170	0.135
DV307ME	1992	03/22/95	8371	M50	12.56	1.479	539.7	0.101	1.502	0.165	0.113	0.158	0.215
DV308ME	1992	09/22/94	27354	M50	11.89	2.101	568.9	0.162	1.162	0.257	0.174	0.245	0.156
DV309ME	1992	05/09/95	3359	M50	11.94	1.270	568.3	0.095	0.613	0.151	0.109	0.136	0.313
				COUNT	7	7	7	7	7	7	7	7	7
				AVERAGE	11.87	1.905	571.8	0.118	0.863	0.192	0.135	0.176	0.216
				STD DEV	0.557	0.385	28.278	0.025	0.335	0.034	0.024	0.034	0.087
				CV	0.047	0.202	0.049	0.208	0.388	0.180	0.179	0.195	0.405

FFV FORD ECONLINE VAN - M85 TESTS AT LAB 2

NREL VEH ID	MODEL YEAR	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
DC301ME	1992	02/01/95	17326	M85	8.23	1.713	586.0	0.072	0.751	0.192	0.149	0.115	0.405
DC302ME	1993	02/15/95	13376	M85	8.14	1.261	593.1	0.043	0.735	0.170	0.133	0.079	0.234
DC303ME	1993	02/15/95	28151	M85	8.33	2.088	578.5	0.059	0.631	0.236	0.197	0.098	0.334
DC304ME	1992	04/03/95	18156	M85	8.22	1.257	587.0	0.048	0.859	0.157	0.125	0.079	0.372
DC305ME	1992	02/07/95	23823	M85	7.95	1.132	607.5	0.044	0.645	0.154	0.121	0.076	0.244
DC306ME	1993	05/12/95	12924	M85	8.52	1.829	565.0	0.063	0.803	0.251	0.211	0.103	0.158
DC307ME	1992	04/26/95	13590	M85	8.47	0.888	570.4	0.041	0.737	0.133	0.103	0.071	0.222
DC308ME	1992	08/18/94	10329	M85	8.85	1.758	544.1	0.075	0.578	0.188	0.148	0.115	0.243
DC309MEC	1992	06/29/95	36165	M85	7.69	2.890	624.6	0.054	1.068	0.160	0.126	0.088	1.222
				COUNT	9	9	9	9	9	9	9	9	9
				AVERAGE	8.27	1.646	584.0	0.055	0.756	0.182	0.146	0.091	0.381
				STD DEV	0.317	0.571	22.259	0.012	0.138	0.037	0.034	0.016	0.306
				CV	0.038	0.347	0.038	0.217	0.182	0.203	0.232	0.173	0.803

FFV FORD ECONLINE VAN - M85 TESTS AT LAB 3

NREL VEH ID	MODEL YEAR	TEST DATE	TEST ODOM	TEST FUEL	Exhaust Emissions (g/mi) MPG	CO	CO2	NMHC	NOx	OMHCE	OMNMHCE	Exhaust HC(total)	Evap HC(total)
DV301ME	1992	04/07/95	20616	M85	7.56	1.122	562.7	0.057	0.450	0.160	0.127	0.091	0.167
DV304ME	1992	11/09/94	12869	M85	7.84	1.018	542.4	0.076	0.906	0.134	0.115	0.095	0.562
DV305ME	1992	05/02/95	19658	M85	7.42	1.134	573.4	0.078	1.308	0.167	0.131	0.113	0.151
DV306ME	1992	08/18/94	5183	M85	7.74	1.650	548.3	0.038	0.711	0.134	0.101	0.072	0.169
DV307ME	1992	03/23/95	8404	M85	7.99	1.387	531.9	0.080	1.741	0.148	0.116	0.109	0.123
DV308ME	1992	09/21/94	27320	M85	7.79	1.556	544.8	0.106	0.989	0.215	0.168	0.153	0.164
DV309ME	1992	05/11/95	3427	M85	7.85	1.221	541.4	0.043	0.566	0.116	0.093	0.067	0.246
				COUNT	7	7	7	7	7	7	7	7	7
				AVERAGE	7.74	1.298	549.3	0.069	0.953	0.153	0.122	0.100	0.226
				STD DEV	0.179	0.221	13.069	0.022	0.416	0.030	0.023	0.027	0.141
				CV	0.023	0.170	0.024	0.321	0.437	0.193	0.187	0.269	0.625